TRANSFER OF TECHNOLOGY FROM A GOVERNMENT R AND D INSTITUTION TO INDUSTRY

by

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INDUSTRIAL AND MANAGEMENT ENGINEERING PROGRAMME

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CERTIFICATE

This is to certify that the present work on "Transfer of Technology from a Government R and D Institution to Industry." by Mr. Arnab Bhattacharya has been carried out under my supervision and has not been submitted elsewhere for the award of a degree.

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ABSTRACT

The importance of the study in Intra-national Technology Transfer is discussed. The relevant literature on technology transfer and innovation process is reviewed. Six technologies developed in National Sugar Institute, a Govt. controlled R and D institution, are then selected to study their transfer process from NSI to the sugar mills. Six cases exhibiting the technology transfer process are then built-up using interviews of the senior scientists of NSI and senior management personnel of four sugar mills. These six cases are then analysed with a focus on both the source and the users to gain an understanding of the different factors influencing the transfer process and the different stages of it. Using the insights gathered from the analysis, a model depicting the technology transfer process is proposed.

Besides, a set of guidelines is suggested for making the intra-national technology transfer process more effective.

CHAPTER I

INTRODUCTION

1.1 Infrastructure for Technology for Development in India:

The study of technology for development has recently been the focus of attention in developmental studies. The process by which technological advances, ideas or invention are translated into products, processes, or services has become of increasing concern in recent years [1].

The increasing technological gap between the western and developing nations seems to be one of the significant causes of the widening economic gap between them [2]. A simple chart used in the report of Commission on International Development (London, 1969) would speak for this imbalance [3].

	Developed Countries	Developing Countries
Population (Percentage of World)	34.0	66.0
GNP (Percentage of World)	87.5	12.5

India is one of the major developing nations who have attempted to build institutional infrastructure to develop technological capability in order to reduce the technological gap.

Like many third world countries, India has given priority to the use of science and technology for development, particularly in the fields of agriculture and industry. The implementation of this policy involved the establishment of institutions for the purpose of undertaking basic and applied research, the acquisition of technology from developed countries for setting up industries in the public and private sectors and the gradual process of acquiring self reliance by developing indigenous sources of technology. Thus, the strategy of development enunciated in the five year plans recognised the importance of science and technology in the promotion of development [4].

A base for developing source and technology was established by setting up advanced centres of education and scientific research. Prominent of these were the forty four national and regional laboratories under the Council of Scientific and Industrial Research (CSIR), the higher institutes of technology and management and advanced centres for specialised research and teaching in science and technology [5]. A separate Ministry of Science and Technology was set-up in 1972 supported by National Committee of Science and Technology (NCST). The NCST which coordinates policy produced the first science and technology plan (1974-79) which envisaged an investment of Rs. 1796 crores. The outcome of this policy is that India stands third, next to USA and USSR in the field of technological and scientific manpower [6].

Despite the existence of a wide range of institutions, the link between them and the industrial sector is not too strong. Also, policy decisions affecting both the scientific institutions and the public industrial sector are determined by the central bureaucracy. The nature of communication among the three segments has implications for the transfer of technology [7].

For transmitting the research undertaken in the Govt. controlled laboratories to the users, there are two semi-autonomous agencies - the National Industrial Development Corporation (NIDC) and the National Research Development Corporation (NRDC). The NIDC was set-up in 1969 for the purpose of undertaking research and consultancy business in metal mining, automobiles and paper industries. The NRDC was set-up in 1953 (i) to undertake the transfer of technology and licensing of know-how developed by R and D institution in the country, (ii) to promote development projects in collaboration with industry, (iii) to promote Indian technology abroad, and (iv) to encourage inventive talent in the country [8].

The sugar industry being the second largest agriculture based industry (after the textile industry) has to play a very important role in the Indian economy. The National Sugar Institute, Kanpur, is a source of new technology for this industry, and related organisations, such as sugar machinery and instrument and chemicals manufacturers.

At the national level the utilisation of indigenously developed technology is shockingly low. A study of one technology source like NSI might go a long way in understanding the technology transfer process from a National Laboratory and the various interacting factors involved in it.

1.2 The Importance of Studying Intra-National Transfer of Technology in India:

Despite the fact that India is ranked third in the world in the Scientific and Technical Manpower and the rate of growth of S and T manpower during 1950-75 has been as high as 9.1 percent and that almost all the structural ingredients required to make a technological breakthrough are independently present in the economy, the Indian record of commercialisation of indigenously developed know-how is quite dismal. This can be demonstrated most effectively by considering the records of the premier research organisations in the field of industrial research in India, CSIR. The importance of choosing CSIR records as our data base lies in the fact that in the field of industrial research, CSIR occupies a position of virtual monopoly since the early forties. By the year 1977, the CSIR, which is an autonomous government organisation, controlled a chain of forty-four laboratories which together covered R and D in virtually the entire range of industrial products and processes. The CSIR group of laboratories alone accounted for 68 percent of the expenditure in industrial research in 1977 [9].

Writing on the Problems of Research Utilisation, Baldev Singh (In-charge of Technology Utilisation, CSIR, in 1970) gave a grim picture of the Indian scene. "Of nearly 1,500 or so patents taken out during last 20 years, not more than 180 are in actual production. Of the 800 or so processes referred to NRDC till April, 1969, less than one-sixth were in active production while practically 50 percent were dropped, withdrawn or released free of charge" [10].

Statistics published by the Department of Science and Technology (DST) show that by the year 1977, 1611 effective inventions were reported by the CSIR. CSIR's own publications show that by March, 1977 the total number of processes offered by the CSIR for which the licenses and patents were valid were 766. Of these 289 processes, roughly 38 percent were in production, 275 processes, roughly 36 percent had been sold to industries but production had not started for one reason or the other, 72 processes were being offered free of cost to the industries but had not been licensed for production so far, 92 processes had been developed only in 1976-77 and 38 processes were being used internally by CSIR laboratories themselves [11].

The R and D expenditure of a country can be taken as a rough indicator of the amount of effort being made to develop indigenous technology. Referring to Table 1, we see that in 1985-86, the total expenditure on R and D was Rs. 2180.63 crores (Central, State and Prive Sector). During the period 1948-49

to 1985-86, the share of R and D expenditure as percent of GNP rose 17 times from 0.054 to 0.73. Against this, the corresponding figure is much higher in other countries like the USA (2.8% in 1984), the USSR (4.7% in 1983), Japan (2.6% in 1983), Yugoslavia (0.8% in 1980), China 1.0% in 1978), South Korea (1.04% in 1983). CSIR's expenditure in R and D for the year 1983-84 was Rs. 9750 lakhs. Compared to this, the royalty and premia earned by NRDC in 1983-84 was Rs.106 lakhs only [12, 13].

Apart from this financial indicator, another indicator was available from NRDC's 32nd Annual Report (1985-86) regarding processes referred to it for development and commercial exploitation (Table 2).

The figures above spoke for themselves and reinforced Baldev Singh's earlier statement on technology utilisation in India. In a developing country like ours, the production of new technology could justify itself to the extent that it reached the users it was developed for, and to the extent these users utilised it.

In a series of training programs which the members of the Program of Research on the Management of Research and Development (POMRAD) conducted in Brazil in 1973 it turned out that the greatest weakness of the research institutions in the developing countries is the lack of experience with, interest in, and ability to perform this necessary "marketing of technology" function [14].

Table 1: Expenditure on Research and Development: 1948-49 to 1985-86.

Year	Rs. crores				to total R and D Expenditure			Total R and D expenditure as% of GNP.
	Central Govt.	State Govt.	Private Sector	Total	Central Govt.	State Govt.	Private Sec.	
48-49	1.10	NA	NA	1.10	100	-	-	NA
50-51	4.68	NA	NA	4.68	100	-	-	0.05
55-56	12.14	NA	NA	12.14	100	-	-	0.12
58-59	27.66	1.00	0.15	28.81	96.0	3.5	0.5	0.21
65-66	79.12	3.51	2.43	85.06	93.0	4.1	2.9	0.36
68-69	109.60	11.99	9.85	131.44	83.4	9.1	7.5	0.40
69-70	121.26	12.22	12.81	146.29	82.9	8.3	8.8	0.40
70-71	146.20	12.58	14.59	173.37	84.3	7.3	8.4	0.43
71-72	159.07	9.53	16.18	184.78	86.1	5.2	8.8	0.43
72-73	189.05	22.11	22.84	234.05	80.8	9.4	9.8	0.49
73-74	199.05	24.13	30.35	253.53	78.5	9.5	12.0	0.43
74-75	258.92	28.65	36.46	324.03	79.9	8.8	11.3	0.47
75-76	323.70	31.94	42.35	397.99	81.3	8.0	10.6	0.54
76-77	310.49	32.05	48.42	390.96	79.4	8.2	12.4	0.49
77-78	355.53	36.50	58.20	450.23	79.0	8.1	12.9	0.50
78-79	431.81	51.01	75.87	558.69	77.3	9.1	13.6	0.57
79-80	523.43	58.76	92.14	674.33	77.6	8.7	13.7	0.63
80-81	617.22	75.73	120.69	813.64	75.9	9.3	14.8	0.64
81-82	765.15	91.30	147.00	1003.45	76.3	9.1	14.6	0.68
82-83	936.57	121.86	196.98	1254.96	74.6	9.7	15.7	0.76
83-84	1082.28	150.90	207.83	1441.01	75.1	10.5	14.4	0.76
84-85	1474.98	178.85	236.75	1890.58	78.0	9.5	12.5	0.89
85-86	1696.22	200.31	284.10	2180.63	77.8	9.2	13.0	0.90

Table 2: Commercial utilisation of processes from NRDC.

Year	Processes referred	New Licences negotiated	Processes gone into production
1977	97	166	18
1978	90	167	21
1979	46	144	12
1980	45	132	17
1981	41	119	10
1982	33	128	8
1983	28	120	11
1984	25	136	5
1985	17	138	5
1986	22	140	4

Thus the study of Intra-national technology transfer is an important, indeed a vital, area of study.

1.3 The Sugar Industry:

India is the fourth major sugar producing country in the world, the first three being USSR, Brazil and Cuba in that order. Sugar Industry occupies an important place among organised industries in India. It ranks third largest industry in terms of its contribution to the net value added by manufacturers and ranks second largest industry in the agriculture based industrial sector. It has a total capital investment of over Rs. 1350 crores and employs nearly 3.25 lakh workers, besides creating extensive indirect employment for 25 million cultivators of sugarcane, the various agencies of distributive trade and through subsidiary industries such as confectionary. It is also an important source of excise duty for the Central Government [15].

1.4 The Present State of Sugar Industry:

The sugar industry is divided into Private, Government, Joint and Cooperative sector. In 1930s when the modern sugar industries first emerged in Indian scene, almost all the output used to come from the private sector companies. But with the emergence of rapidly growing cooperative sector from 1950s, the share of private sector has dropped to 25 percent, with the cooperative sector is giving 60 percent of the output [16].

But at present the sugar industry is plagued by severe industrial sickness. Bhargava Commission, appointed by Govt. of India, undertook detailed study of every single factory in the country during 10 years period from 1960-61 to 1969-70 and found out that 32 percent of total factories incurred actual losses on their working during the said period. Even among profit making units a large majority made only very meagre profit which is much below Government's own norms as per the recommendation of bodies like Tarriff Commission, BICP etc. Taking into account these units, percentage of sick units goes upto as high as 65 percent. Net worth of a large number of units has been completely eroded and in many cases factories have been compelled to take sizeable amount of loan from State Govts. and banks first to liquidate overdue sugar cane payment to cultivators. Uttar Pradesh Government had to provide loan or subsidy of Rs. 100 crores per year, whereas the figure of Bihar and Andhra Pradesh stands at Rs. 20 crores and Rs. 25 crores per year respectively. All other states had to share a heavy burden of the loans and net worth of the industry stands at a negative figure (total and sector-wise both)[17].

There is considerable scope for added inputs as well as undertaking systematic and extensive modernisation and rehabilitation to bring the industry to realise its fullest potential. The productivity per man-hour has been assessed at 34 tonnes of sugar in India against 100 tonnes per man-hour in neighbouring

developing countries [18]. Sugar recovery from sugar-cane is 9-10 percent in India compared to 12-13 percent in other major sugar producing countries. India has the largest sugar cane acreage in the world and contributes to 25 percent of the world sugar-cane production but its share in cane-sugar production, excluding non-centrifugal sweetners (gur and khandsari) is hardly 10 percent [19].

India is one of the few major sugar producers which relies on a system of small cane growers. In some Indian factories the number of growers may be as large as 40,000. As against this an Australian factory may have around 80 cane growers.

In the 1965-66 season, Govt. for the first time declared a policy of partial decontrol allowing the industry to sell 40 percent of the output in free market. The industry responded with a record production of 35.36 lakh tonnes.* But next year due to drought, the production suffered. But the industry maintained the growing trend and in 1974-75 season, achieved a record production of 47.9 lakh tonnes and exported sugar worth Rs. 500 crores which was also a record. But this policy of partial decontrol and high production could not help the industry to do away with its illness. High cane price, sluggish free market, higher prices of raw materials, higher interest rates, credit squeeze by banks - all contributed to the sickness of the industry.

* See annexure to this chapter

1.5 The Government Sugar Policy:

The Govt. Sugar Policy came under heavy attack from Indian Sugar Mills Association (ISMA). Govt. policy regarding fixing minimum supporting price of sugar cane for sugar mills, fixing the quota of levy and non-levy sugar, fixing the amount of non-levy sugar to be released in the market by the sugar mill, dual pricing policy of levy and non-levy sugar, controlling the price and distribution of molasses, licensing new sugar mills - all were highly criticised by ISMA. Upto 1985-86 season, the ratio of levy to non-levy sugar quantity was 65:35. Annual subsidy which the industry had to provide on levy sugar was of the order of Rs. 300 crores. Industry was expected to recover the subsidy from the sale of free sugar (35 percent of the output). But unrealistic release policy dropped down the price of sugar in free market and during the three seasons from 1982-83 to 1985-86, as a result of Govt. release policy, the industry was estimated to have lost Rs. 800 crores. As a result, many industries were unable to pay dues to the cultivators in time and naturally the cultivators turned towards khandsari and gur producers who were not bound by Govt. controlled supporting price and who simply followed the demand and supply rule [20,21].

This is one of the reasons of low percentage of conversion of sugarcane to sugar in India. Of the total sugarcane produced 55 percent goes to khandsari, 12 percent for planting and chewing and only 33 percent goes to sugar manufacturing.

From 1986-87 season, Govt. changed the ratio of levy to non-levy sugar to 55:45 to improve the viability by sugar mills to enable them to pay competitive cane prices promptly. Government also declared rebate in excise duty on excess sugar production during months of October and November over average quantity produced during corresponding period in the preceeding 2 seasons and differential levy price of Rs. 26/- per quintal applicable to old and weak units [22].

The controlled price of molasses which is one of the very important by-product in terms of contribution (production increased from 2846 thousand tonnes in first plan to 11310 thousand tonnes in fifth plan) was kept at Rs. 60/- per tonne for the last decade was also doubled to Rs. 120/- per tonne in October, 1987. But there is a demand from industry about partial decontrol of molasses i.e. industrial alcohol manufacturers will get levy molasses, but potable alcohol manufacturers have to buy molasses from free market [23].

Govt. policy of proposed licensing of 82 new units during 1980-85 period at a cost of Rs. 574 crores was also questioned as the same purpose could be served by permitting expansion and diverting fund for modernisation of existing factories [24].

As per the findings of Sen Sugar Enquiry Committee and Pasricha Committee, in the Northern states direct link between

sugar-cane growers and factories have been blocked by constitution of statutory bodies, cane cooperative unions for marketing as well as distribution of sugar-cane. These bodies are apparently not equal to the task involved due to lack of technical and managerial capabilities. They have not been able to ensure regular supplies of cane to sugar factories. It is emphasised that there is need to revive direct links between sugar factories and cane growers [25].

Following the recommendation of a high level committee, Govt. decided in 1982 to constitute a Sugar Development Fund by imposing a cess on sugar. This fund has to be primarily utilised for producing seed capital to the needy sugar mills to be able to borrow funds from financial institutions and modernisation/rehabilitation of their plants. But the response is very lukewarm from the industry side [26].

Sugar mills are now concentrating more and more on the fuller utilisation of the by-products, specially bagasse and molasses which is quite encouraging. At present smaller paper plants are coming up to make paper and paper board, packing paper etc. using bagasse which earlier was being used only as fuel. Molasses is now being used for the manufacture of power alcohol, fertilisers, cattle feed etc. [27].

Despite all handicaps and difficulties, no other industry in the country has developed as fast as the sugar industry. The industry has indeed very bright prospects, as there is abundant

supply of raw materials, cheap labour and huge local market [28].

1.6 Research on Sugar Technology:

On the technological front the picture in the industry is not as gloom as it appears from various financial and non-financial indicators. Self-sufficiency has been almost attained in the area of manufacture of sugar machinery. The state of the technology level also is almost at par to that of other countries, especially in the comparatively newer cooperative sector. But the existing technology itself is sometimes unadapted and imperfectly applied. There is tremendous necessity in India to improve productivity of sugar by maintaining efficiency at every stage of operation, quality of sugar and most important of all to reduce the cost of production of sugar. Application of latest technologies in the fields of energy, power/fuel saving, product diversification, power generation, use of improved design continuous equipment, instrumentation is the need of the industry today.

At present, Central Government is maintaining two all India institutes for research in sugarcane and one institute for research in sugar. Factory level participation in research is almost negligible. Amongst over three hundred factories hardly a few would claim to have properly established R and D units. Finally we have three technologists' associations; Sugar Technologists' Association (STA), Deccan Sugar Technologists' Association (DSTA) and South India Sugar Technologists' Association (SISTA), which provide forums for exchange of ideas on the technical problems of the industry [29,30].

To cater to the needs of the sugar mills in the development and utilisation of technology, National Sugar Institute (NSI), the only national level institute for sugar research, maintains advisory services, helps individual factories to solve their local technical problems, conducts seminars in association with STA for popularising improvements and undertakes research on problems pertaining to sugar technology, sugar and sugar-cane chemistry, sugar engineering and on utilisation of by-products of sugar industry.

1.7 Importance of the Study:

The sugar industry, with its low utilisation of crushing capacity, low sugar recovery, agro nature and strict Govt. control, could gain from a study of Technology Transfer process from NSI, i.e., how it receives its technologies, what are the factors influencing this transfer process and whether these technologies are in line with the prevailing and future needs.

NSI is the only national level research institute that looks after the important sugar industry sector. A study of its technology transfer process may go a long way in understanding the situation in the NSI, in the industry and about various internal and external linkages. Some insights can be gained into the process of intra-national transfer in India and guidelines for future investigations can emerge. There will be some direct gains to NSI and its technology users and potential users and knowledge added to that already existing on intra-national transfer of technology.

Annexure to Chapter I

Table 3: Production of Sugar in India.

Year	Production (in lakh tonnes)
1960-61	30.28
1961-62	27.30
1962-63	21.35
1963-64	25.62
1964-65	32.32
1965-66	35.36
1966-67	22.35
1967-68	27.20
1968-69	35.60
1969-70	42.00
1970-71	37.40
1971-72	31.00
1972-73	39.00
1973-74	39.00
1974-75	47.90
1975-76	42.60
1976-77	48.40
1977-78	64.60
1978-79	58.42
1979-80	38.58
1980-81	51.49
1981-82	84.36
1982-83	82.32
1983-84	59.10
1984-85	61.44

Table 4: Sugar-cane Production in the Major Producing States (in lakh tonnes).

States	78-79	79-80	80-81	81-82	82-83	83-84	84-85
Uttar Pradesh	623	512	642	764	813	790	706
Maharastra	225	198	236	288	314	265	264
Tamil Nadu	154	154	186	202	152	145	200
Karnataka	110	97	124	143	149	134	143

Table 5: Sugar Production in the Major Producing States (in lakh tonnes).

States	78-79	79-80	80-81	81-82	82-83	83-84	84-85
Uttar Pradesh	14.62	9.97	12.24	20.80	20.35	17.27	12.78
Maharastra	21.05	13.94	20.85	30.26	30.25	19.93	23.11
Tamil Nadu	4.91	3.67	4.30	7.55	6.52	4.24	4.00
Karnataka	4.87	2.71	3.71	6.48	6.29	3.83	4.41

CHAPTER II

NATIONAL SUGAR INSTITUTE, KANPUR (NSI)

2.1 Brief History of NSI:

The need for a central sugar research institute was recommended by the Indian Sugar Committee of Govt. of India in 1920. It was again emphasised by the Royal Commission on Agriculture in 1928 and the Tariff Board in 1930. The Govt. of India accordingly established the Imperial Institute of Sugar Technology at Kanpur in October, 1936 by taking over the Sugar Section of the Harcourt Butler Technological Institute (HBTI), Kanpur. The institute was placed under the administrative control of the Imperial Council of Agricultural Research but continued to be housed in the building of the H.B.T.I. With its formation in 1944, the Indian Central Sugarcane Committee took control of the Institute. Consequent upon India attaining independence, the name of the Institute was changed to Indian Institute of Sugar Technology. With the enactment of the Industries (Development and Regulation) Act, 1951, the Ministry of Food and Agriculture (Dept. of Food) took over control of the Institute in 1954. In 1957, the name was changed to National Sugar Institute, which moved to an independent campus in 1963.

The NSI has a Khandsari Prayogshala attached to the Institute for providing practical training to the students of Khandsari Supervisor's Course and Khandsari Karigar's Course; besides being used for conducting researches on new equipments and process techniques for Khandsari Sugar manufacture. A Sharkara Prayogshala (Experimental Sugar Factory) of 100 tonnes cane crushing capacity per day has also been set-up as an adjunct to their Institute and it has started operating from the season 1976-77. This Sharkara Prayogshala is being utilised for providing practical training to the students on all practical aspects of cane sugar manufacture and for carrying out semi-large scale trials of the process or techniques which are found giving promising results in research laboratories of the Institute.

There is also a 375 acre farm attached to the Institute. The purpose of the farm is mainly to grow sugarcane and supply the same to the Experimental Sugar Factory and Khandsari Prayogshala.

2.2 Present Status:

The Institute is under the administrative control of the Govt. of India in the Ministry of Agriculture and Irrigation (Department of Food). There is an Advisory Board for the Institute under the Chairmanship of the Joint Secretary (Sugar)

which recommends to the Govt. of India the plans and proposals of the Institute for its development. The other committee members are Under Secretary (Finance) - Ministry of Agriculture and Irrigation (Dept. of Food), President - Indian Sugar Mills Association, other representative from the Sugar Industry, Directors of one or two reputed technical institutes and Director of NSI.

2.3 Functions:

The main functions of the Institute are:

i) To undertake research on (a) problems pertaining to sugar technology, sugar and sugarcane chemistry and sugar engineering in general and those of sugar factories in particular and (b) utilisation of by-products of sugar industry,

ii) To render technical advice and assistance to sugar factories with a view to improve their efficiency and assist other sections of the industry and the Central and State Govt. in matters relating to sugar and allied industries,

iii) To provide technical education in all branches of sugar chemistry, technology and engineering and in Industrial Fermentation and Alcohol Technology and to provide training in research,

iv) To prepare and issue Indian Sugar Standards,

v) To collect, collate and issue technical statistics relating to sugar industry, and

vi) to survey sugar factory plant and process for drawing up detailed survey report including advice, suggestions, long and short term recommendations covering all aspects or any particular field of aspects of the factory working and equipments in order to achieve efficiency and economy at every stage of production.

2.4 Activities:

2.4.1 **Teaching:**

The Institute conducts Post-Graduate Diploma courses in Sugar Technology, Industrial Fermentation and Alcohol Technology, Sugar Engineering and Certificate courses in Sugar Engineering, Sugar Boiling, Pre-Harvest Cane Maturity Survey, Khandsari Supervisors and Khandsari Karigars.

The Institute through conducting these courses caters to the need of Sugar Technologists not only in India, but of some Middle-East and African Countries also.

There is a well maintained library which consists of 6000 books and 30,000 bound journals on scientific, technological and other subjects. More than 150 journals and periodicals are subscribed regularly.

2.4.2 Research:

The Institute carries out research on the day-to-day problems of the sugar and its allied industries. Whereas emphasis is laid on applied aspects, problems of fundamental importance are also undertaken as topics of research. The results of research are published in scientific and technical journals of India and foreign countries. The more promising results are passed through different stages of development culminating in taking out patents in cases where considered necessary.

The Institute has also a system of coordinated research which means that if the Institute has to try out any solutions of problems on factory scale it endeavours to carry out such research trials in collaboration with sugar factories.

2.4.3 Technical Advice and Assistance:

The Institute provides technical assistance to the industry through the following means:

a) Technical Officers and staff of the Institute are deputed to sugar factories on payment of prescribed fees for giving technical advice and investigation of problems on the spot.

b) Improved designs of various equipments used in sugar factories complete with their manufacturing details and diagrams are prepared and supplied to the factories on payment of prescribed fees.

c) Advice is given to promotors of new factories and for expansions and materials used in sugar industry surveys are carried out.

d) Inspection of existing machinery is also carried out.

2.4.4 <u>Extension Service:</u>

It makes available to the Industry the accumulated knowledge, of the Institute through a team of experts in Sugar Technology, Sugar Engineering and Chemical Engineering etc. The appropriate staff makes a detailed on the spot study and investigation and draws up a detailed survey report including advice, suggestions, long and short term recommendations covering all aspects or any particular field of aspects of the factory to achieve efficiency and economy at every stage of production.

2.4.5 <u>Other Activities:</u>

Apart from these, all technical and statistical data of importance to the sugar industry are collected, compiled and disseminated to the sugar industry and all concerned by NSI. The Institute also publishes two quarterly and one annual journals. The Institute issues Indian Sugar Standards, prepares and supplies scheduled culture of various aspects to distilleries and other organisation and takes care of over-hauling, repairing as well as calibration/standardisation of various types of apparatus and instruments used in the sugar factories.

NSI actively participatesin the organising of the Annual Conference of Sugar Technologists' Association (STA).

2.5 Organisational Set-up:

The Institute, with a view to carry out the three main functions viz. teaching, research and advisory in coordination with each other and other functions, maintains a number of separate divisions each headed by a Senior Officer.

The following are the various divisions:

i) Sugar Engineering

ii) Sugar Technology

iii) Sugar Chemistry (Organic)

iv) Sugar Chemistry (Agriculture)

v) Physical Chemistry

vi) Bio-Chemistry

vii) Chemical Engineering

viii) Survey and Information

ix) Advisory

x) Design and Development

xi) Extension Service

Besides the above there is the Administrative Division which looks after the administration of the Institute in respect of accounts, establishment and other related matters.

Divisions (i) to (vii) have research laboratories attached to them and their work involves besides research, teaching and giving technical advice. The Survey and Information Division is

the repository of and clearing house for all technical information received from or supplied to the industry and is responsible for every kind of documentation of technical literatures and information. It coordinates the activities of the various division at the Institute among themselves and those of the Institute with the industry.

The organisation structure is given in Fig. 1.

2.6 Full Time Personnel Employed in NSI in 1985-86:

No. of personnel in R and D	58
No. of Scientific and Technical Personnel engaged in auxiliary technical activities including skilled workers and technicians	203
No. of personnel employed in administrative and other non-technical activities including class IV unskilled staff	107
Total:	368

2.7 Expenditure at NSI:

	Expenditure in Rs. Lakhs		
	1984-85	1985-86	1986-87
Revenue/Recurring	92.53	100.87	114.97
Capital	17.27	6.36	57.73
Total	109.80	107.23	172.70

ORGANISATIONAL SET UP OF NATIONAL SUGAR INSTITUTE, KANPUR

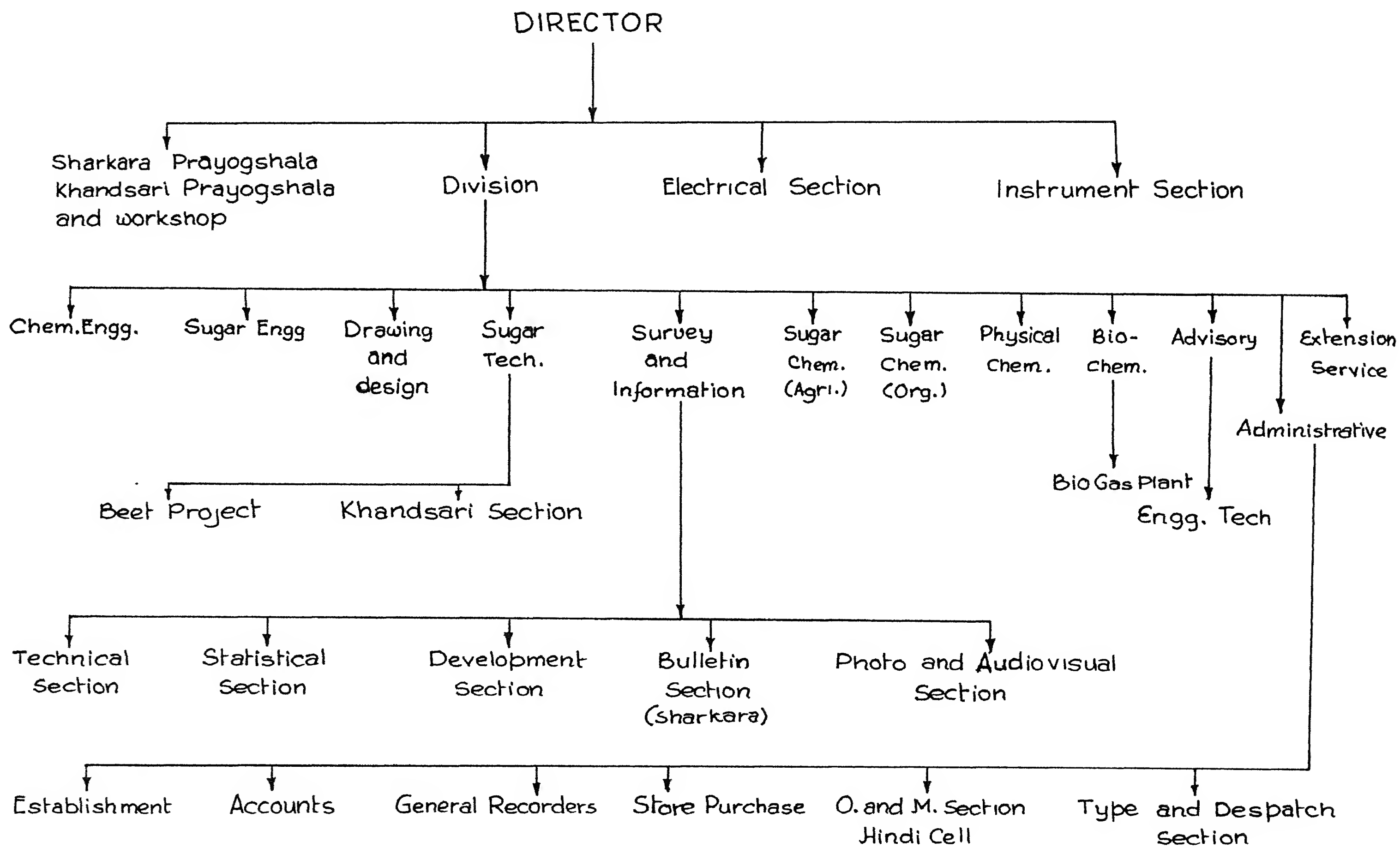


Fig.:1

2.8 Organisational Climate:

NSI inherits the rule-boundedness of its controlling organisation, viz. the government. The hierarchy is rigid and scientists have to take permission of the Director for any liaison work with outside. They have to ask for prior approval from the Department of Food before attending any seminar or conference. NSI does not approve consultancy work by its scientists. The salary is quite low compared to the industry. There is no performance based appraisal system and promotion is strictly vacancy-based. All qualified personnel are recruited through UPSC.

CHAPTER III

SURVEY OF LITERATURE

3.1 Technology and Innovation:

Technology refers to different types of knowledge, which may be embodied in the form of machinery or equipment or in the form of information (like designs or specifications), or in the form of know-how (like technical and managerial skills) [31].

If we want to highlight the aspect of "newness" to the definition, it is necessary to introduce the term "invention"

"Invention" has been defined as the "conceptualisation of a new idea" [32].

The term "innovation" took the concept of technology one step forward. It was defined as "introduction of new things or methods" [33] or "the process of bringing invention into use" [34].

3.2 Transfer of Technology:

Transfer of technology is a process - a continuous series of actions over time - that starts with invention and ends in use. "A product must be sold, a piece of equipment must be used, or a unit of military weaponry must be put into production in order to qualify as examples of transferred technology" [35].

Technology transfer can be either vertical or horizontal. Vertical transfer is generally internal to the enterprise and takes place by the incorporation of new scientific knowledge from the idea stage to its final development. Horizontal transfer involves the transfer of proven and tested technology from one industry or country to be adopted, modified or applied in another industry or country [36]. Transfer from independent lab. to industry is a variant of vertical transfer.

3.3 Models of Transfer of Technology:

Some of the more simplistic descriptionsof Transfer of Technology that are available in literature are reviewed below.

3.3.1 The Science - Technology Utilisation Topology:

This model provides a topological view of the relationship between science, technology and the ultimate uses of science and technology. The model presents, through time, the flows of science, technology and the utilization of technical outputs. Transfer can occur between the three flows (e.g. from technology to use or from science to technology)[

3.3.2 Probabilistic Transfer Model:

Probability of Transfer = P (idea) → P (Research)
→ P (Development) → P (Producti
→ P (Innovation) → P (Diffusio

This model provides a sequential series of probabilities that might be considered in order to determine whether the given technical information would be transferred into a new use that would itself result in eventual diffusion. In contrast to this model, with its concentration on the process within an organisation, a third model was developed that focuses on the structure of the transfer process [38].

3.3.3 Functional Transfer Model:

Magnitude of Transfer = f (source, nature of item to be transferred, structure of channels for transfer, potential recipients of items to be transferred).

This model does not have direction in it. A solution to this model will often give insight into the previous model. The independent variables will often be related to one another, and a given problem would have to be solved simultaneously rather than sequentially [39].

3.3.4 The Dissemination and Utilization Model:

It takes into account the influence of at least one aspect of the environment in which technology transfer occurs – the Government. It shows the various concerns of the Government, and explains that Govt. can either delegate these concerns to sub-agencies, contract them out, allow self-governance, or simply allow natural forces to have play. It recognises that various sub-system themselves can influence the Government

environment. This model recognises that there is mutual influence between the various sub-systems[40].

3.3.5 The Utilisation of Knowledge Model:

This model highlights the complexity of the transfer process and the multiplicity of variables involved [41]. The model is shown in Fig. 2.

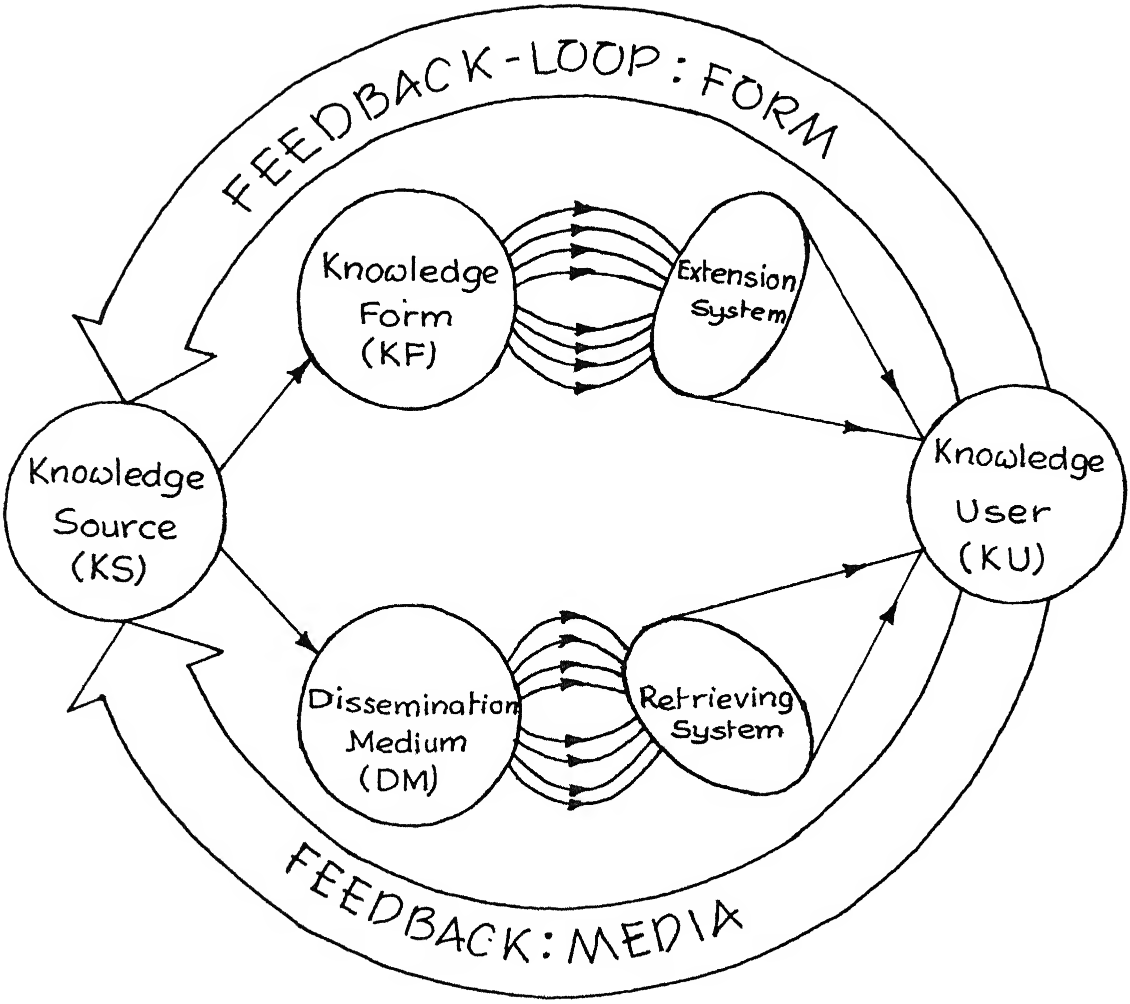
The Knowledge Source (KS) could be an individual (or an institution) and the variables affecting transfer at this stage includes the value systems and attitudes of the KS, its status and credibility, its organizational climate, communication systems, leadership patterns, reward systems etc.

Knowledge Form (KF) is the physical manifestation of the technology (research reports, tables, conceptual models etc.) and its characteristics.

Dissemination Media (DM) includes radio, films, exhibitions, books, word of mouth etc.

The Knoeledge User (KU) is the target of the transfer process and its characteristics include motivation, values, change proneness, socio-economic status etc.

The Extension System [ES] bridges the gap between KS and KU. This bridging is done by specially training change agents, or by setting up special bodies.



A Circular Model of Knowledge Utilisation

Fig.-2.

Retrieval System (RS) is the effort made on the part of the knowledge user to keep in touch with the changing technology around him. It can be done by setting up a separate department for scanning latest industrial knowledge, by subscribing to relevant journals and setting up an extensive library, or by appointing a single individual who plays a gate-keeper's role [42].

The model conceptualises a feedback loop from the knowledge user to the knowledge source.

3.3.6 Buttner and Cheaney Model:

This model, also known as Modified Integrated Model and developed by Buttner and Cheaney stresses that the scope of organizations and their future directions are determined by which needs they were catering to in the social plane and by the nature of the resources they draw upon from the science plane. Thus organisations themselves are knowledge sources but are influenced by their inter-relationships with the social (market) environment and science (technology) environment [43].

3.4 Brief Review of the Innovation Process.

R and D management is the process of organising and motivating scientists, engineers, and others involved in the innovation process so as to ensure that the processes of discovery and communication are effective in meeting the objectives of the sponsoring organisation and of society [44].

Most innovations, especially the successful ones result from a conscious, purposeful search for innovation opportunities, which are found only in a few situations. Four such areas of opportunity exist within a company/industry:

(i) Unexpected occurrances,

(ii) Incongruities,

(iii) Process needs and

(iv) Industry and market changes.

Three additional sources of opportunity exist outside a company/industry in its social and intellectual environment:

(i) Demographic changes,

(ii) Changes in perception and

(iii) New knowledge.

Because innovation is both conceptual and perceptual, would be innovators must also go out and look, ask, listen. To be effective, an innovation has to be simple, and it has to be focussed. Innovation is work, rather than genius. It requires knowledge, ingenuity, focus. It requires hard, focussed, purposeful work [45, 46].

Donald A. Schon suggests that both invention and innovation are widely misunderstood because although they are essentially irrational and uncertain in their nature, many business executives tend to idealise them as "essentially rationa deliberate process in which success is assured by intelligent effort" [47].

Tom Burns and G.M. Stalker report the results of 20 studie in England which convinced them that there is a clear correlatio between success in technological innovation and the adoption of an organic (as compared to mechanistic) system of organisation [48].

The scientific and technical communication activity is an essential element in achieving high R and D productivity as well as successful innovation experiences. R and D managers should nurture the informal i.e. organic structure and "technolo gical gate-keepers" who maintain the inter- and intra-department information flows and they must determine the appropriate manage rial approach to achieve the desired information exchanges [49].

E von Hippel has linked the R and D function with the innovative process where the end product is used. The current prevailing assumption among practitioners of innovation in industrial firm is that the user's share in the innovation process is simply to have "needs" which the manufacturer can explore via market research. According to Hippel, in some

industries the user's role is typically far greater, involving the design and fabrication of a home "built" version of the innovation and proof of its value via field use [50].

Every successful innovation starts from a creative idea, whether it be a new application for a technology, the satisfaction of a new identified need or of an old need in a new way, or the manufacture of a product by a different method. There is no simple recipe leading to the attainment of a creative organisation, nevertheless, it is possible to identify some of the ingredients - creative people, an environment receptive to new ideas, and the use of creative problem - solving techniques. While recognizing that chance plays a major part and the highly creative act cannot be planned, action can and ought to be taken by the R and D manager to ensure the identification and removal of barriers to creativity, to provide stimulus for new ideas and to create a creative environment [51].

An overview of the innovation process is sketched in Fig. 3. Since innovation must move across the spectrum from research into production and sales, the number of roles and people involved are many. J. Smith and others studied a sample of 10 innovations at a particular firm, Union Carbide. In all they proposed twelve kinds of roles as essential for successful innovation process:

OVERVIEW OF THE INNOVATION PROCESS

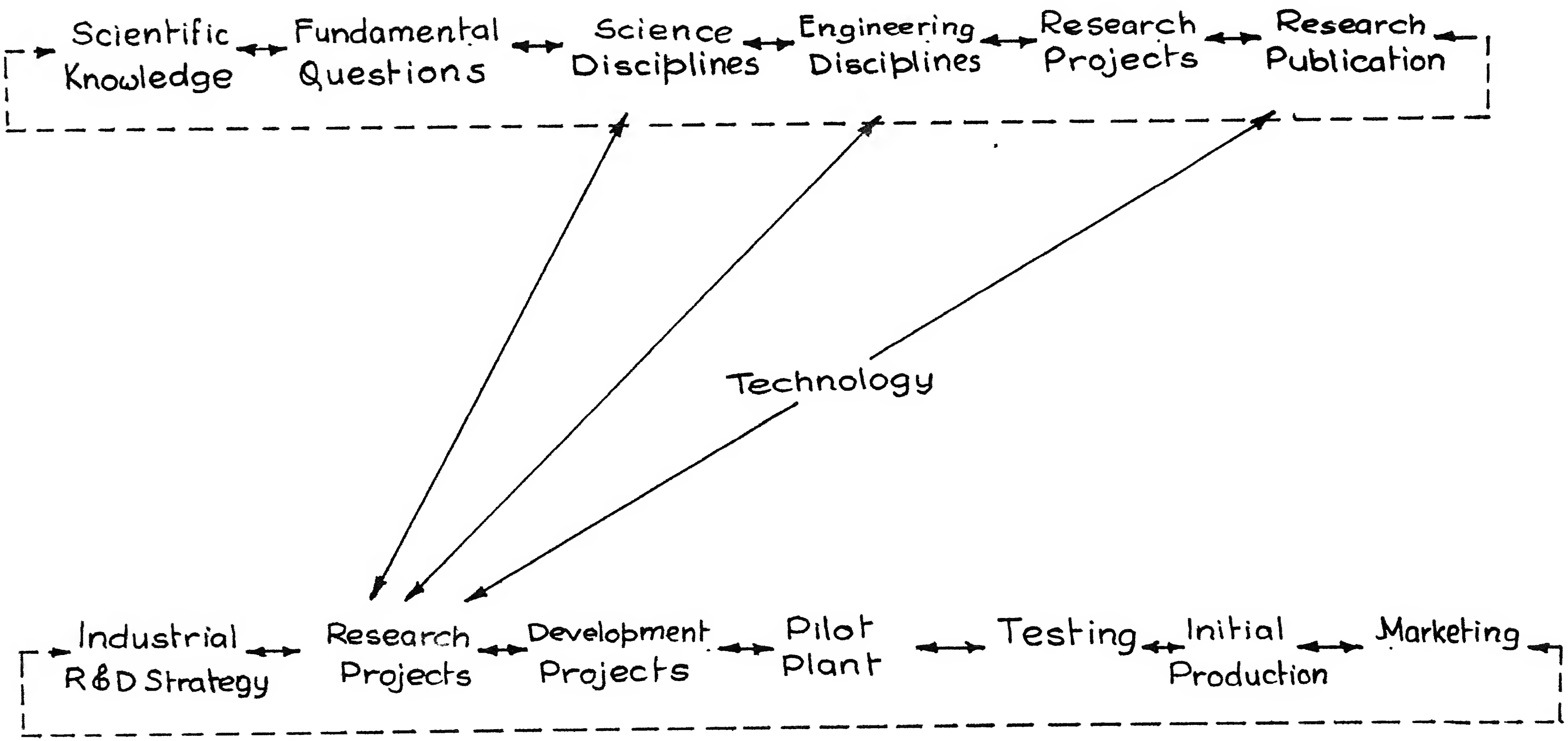


Fig. - 3

1. Scientific Gate-keeper,
2. Process User Gate-keeper,
3. Product User Gate-keeper,
4. Idea Generator,
5. Process/Product Champion,
6. Problem Solver,
7. R and D Sponsor,
8. Project Manager,
9. Quality Controller,
10. R and D Strategist,
11. Business Sponsor, and
12. Top Management.

These roles can be played by one or several people [52].

3.5 International Transfer of Technology:

The term "transfer of technology" is practically synonymous with "International transfer of technology". International technology transfer has acquired great significance for the developing countries as it is seen as one of the major routes for enhancing their technological capability.

Shekhar Chaudhuri while describing the technology transfer process to two Indian Tractor Manufacturers has divided the process in five sequential stages - acquisition, absorption, adaptation and assimilation of the foreign technology and generation of technical know-how appropriate to their own need. He has used the framework of corporate strategy to show

the transfer process in interaction with the external environment, especially the government policy, the organisation characteristics and the corporate strategy in conjunction with technology choice and marketing policy [53].

Mascarenhas has also used the framework of corporate strategy to describe the technology transfer process to HMT Ltd. [54]. He has divided the whole transfer process into different stages:

i) Organisation Development - Building initial organisational structure, developing initial problem solving and diagnostic capability at General Management Level.

ii) Search and Acquisition - Searching and licensing of technology,

iii) Absorption of Technology through Maintenance and Modification - There are three sub-stages in this stage:

a) Access Stage - Capability is transferred to a point where technical direction is provided by the collaborator to enable the achievement of the targeted performance.

b) Absorption Stage - it has been done by "learning by doing" process at HMT.
Various phases of this stage are:
Do-how, Selective Specialisation, Know-how, i.e., indigenous development and modification and lastly Know-why, i.e., design, development and manufacturing.

iv) Generating Technology or Adaptation through in-house Research and Development effort.

When discussing the Indian experience, the underlying assumptions of all studies on the transfer of technology run along the following lines: [55]

1. That the transactions in the transfer of technology take a North-South direction, thus reflecting a technological gap between the seller and the buyer.
2. Technology is important for national development but needs to be adapted to the conditions in developing countries, because factor endowment and factor proportions of production are different.
3. The bargaining relationship between the buyer and seller of technology is weak owing to the absence of skill and technological capability.
4. Realising the importance of such technology to these countries, it is essential to establish appropriate mechanisms to regulate the flow of such technology.
5. To ensure that countries are in a position to absorb and adapt such technology, it is necessary that they clarify the terms of such transfer and type of payments and avoid restrictive clauses.
6. If countries wish to transfer technology successfully, they must then lay emphasis on science and technology policies which are likely to encourage the development of technological capabilities.

Dr. M.S. Mitra has stressed upon the role of consultants for successful technology transfer. It is not enough to effectively carry out a transfer of technology at any given moment but it requires indigenous development of the acquired technology through scientific discovery and technical innovations. Consulting Engineers can play a very important role in technology transfer by actively taking part in feasibility study, preparation of project report, detailed engineering, equipment procurement, construction, mechanical completion and commissioning of the plant [56].

3.6 Intra-national Transfer of Technology:

The increasing gap between the western and developing nations seems to be one of the significant causes of the widening economic gap between them. The technology used for producing the goods that are not imported is mostly imported creating a form of unending dependence of the developing countries on the industrialised ones. This dependence is increased because of the lack of capability of the developing nations to adapt - and assimilate foreign technology when it is unsuitable. Many developing nations have attempted to build institutional infrastructures to develop technological capability. India has placed major emphasis on developing scientific and technological capabilities [57].

In order to encourage utilisation of indigenously developed know-how and promote in house R and D, various policy measures have been adopted by the Govt. in our country. Mainly two types of policies affect R and D activity and its commercial utilisation. First, those measures which are offered by the Govt. in order to promote R and D and the incentives offered by NRDC to firms and entrepreneurs for purchase of locally developed technologies. Second, the protection offered to indigenous know-how against foreign know-how by the fiscal and licensing mechanism. But still there are instances of the inability of the system to absorb indigenously developed know-how into the structure despite these measures of encouragement and protection. Several explanations have been advanced and we shall briefly go through them.

Firstly, there are problems related to the organisational aspects of the Indian R and D system, e.g., doubtful selection of priorities by Govt. controlled laboratories, deficient, sometimes obsolete and incomplete nature of the indigenously developed technology, non-availability of pilot plant making facility, lack of risk capital for the entrepreneur at the development stage, indifferent back-up services etc. The second set of explanations refer to the faulty protection and control policies and even more faulty implementation policies. The apparatus of production, development, control and distribution

in industrial innovation in India has been worked out on the premise that increased state-activity would gradually stimulate conditions for technological change. The private sector enters the innovation chain mainly as the biggest target consumer group of the state-sector-developed industrial innovations. Its contribution to either expenditure or the actual conduct of industrial research is negligible and therefore it has almost no stake in the success of indigenous technology. Since in this set-up industrial research is being carried out in isolation in state-sector laboratories, segregation of research from production on one hand and an interface problem between the state sector and the private sector at the marketing stage complicate the situation [58].

Shekhar Chaudhuri in his Swaraj Tractor Case [59], has described the technology transfer process from Central Mechanical Engineering Research Institute (CMERI), one of the CSIR laboratories, to Punjab Tractors Limited (PTL) with a focus to the management problems in technological innovation. He has divided the innovation process into three phases:

i) Entrepreneual i.e., creation of organisation,

ii) Technology Development and Transfer stage through "reactive muddling through" approach,

iii) Planned learning i.e., Technology Absorption stage.

Positive factors which have contributed to the process are:

i) Presence of Product-Champion,

ii) Able leadership,

iii) Continuity of team from design to implementation,

iv) Good rapport among team members which have resulted into fast decision making and formation of an organic linkage between technology development stage and productionising stage, and

v) Presence of a consulting firm.

Overall the influencing environmental factors are:

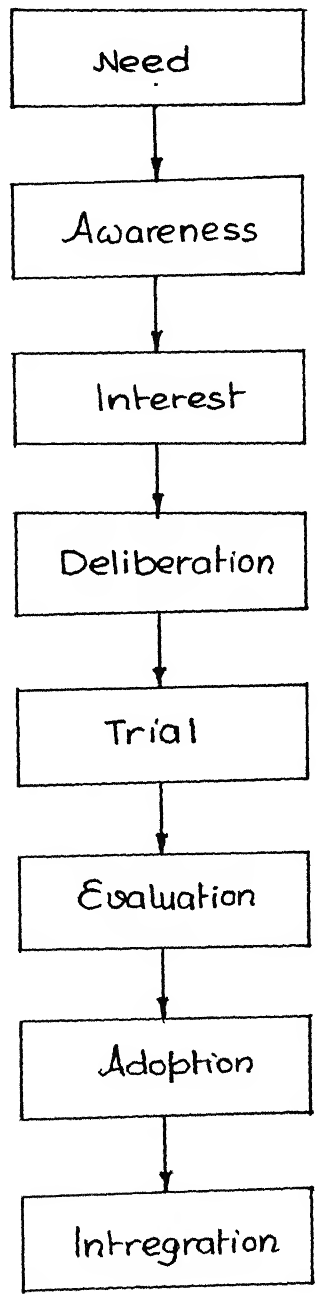
i) economic, ii) political, iii) social, iv) technological v) market related, vi) regulatory and vii) physical or ecological, whereas the internal or organisational factors are: i) goals, ii) leadership style, iii) resources, iv) capabilities, v) organisation structure and vi) information flow system.

V.V. Bhatt has proposed a model of the innovation process from the Swaraj Tractor Case [60]. The model is basically consisting of five different stages linked sequentially. The five stages are: i) opportunity identification, ii) technology development, iii) project formulation and technology transfer, iv) technology utilisation and v) technology updating. The external and internal factors discussed earlier are interacting with the process at different stages.

Z.H. Gangjee has studied the technology transfer process from Ahmedabad Textile Industries Research Association (ATIRA), a CSIR financed autonomous R and D Center, to textile and related industries [61]. He has given a model of "sequential adoption" which depicts various stages of the adoption process (Fig. 4). According to him the transfer process is never as "neat" . At each stage of the transfer process, the concerns that become dominant during other stages exert and influence - to a greater or lesser degree.

The Model of Sequential Adoption

Stage	Psychological Process	Behavioural Outcomes
Need	Arousal	Readiness, dissatisfaction with the present stage
Awareness	Selectivity and stimulus	Seeing or hearing about the innovation
Interest	Orientation and exploration	Gathering more information
Deliberation	Cognitive reorganisation	Discussion and planning
Trial	Expectancy	Tentative adoption in case of expected result
Evaluation	Reinforcement	Collecting further evidence
Adoption	Acquiring new-learned drives	Extended use of innovation
Integration	Generalisation of the learned behaviour and inhibition of older modes of behaviour: consumatory response	Change of attitude and acceptance as a part of the total behavioural complex, with secondary change in other forms of behaviour, communicating behaviour reinforcing adoption.



Sequential Adoption Model

Fig : 4

3.7 Summary of Literature Surveyed:

In studies throughout the literature, there are indications that technology transfer is a complex process and can be better understood if viewed as bi-directional. There seems, a need to understand the total process of technology transfer with equal understanding of the source and the user and what happens between them. The literature repeatedly stresses that successful transfer can take place only when there is a mutual understanding of both source and user and of the environment in which they function and which influence them.

The literature has highlighted the importance of individuals. They appear as "Product Champions" or "Leaders" or "Gate-Keepers", confronting and overcoming obstacles, or acting as "linkages" who understand the reality of source and user, and as "interpreters" of the environment.

CHAPTER IV

SCOPE AND DESIGN OF STUDY

4.1 Introduction:

In this chapter, the study problem is stated at first. After the scope is delineated, the chapter deals with the design of the study - its rationale and the stages.

4.2 Statement of the Problem:

To understand the process of technology transfer from National Sugar Institute (NSI) to sugar mills and to propose a model of intra-national technology transfer thereafter.

4.3 Scope:

The scope of this study includes looking at NSI as a source of technology and the process of its technology being transferred to users. It encompasses the environment that is operating at the time of transfer.

The time period of the study includes looking at the transfer process from 1960 till the last transfer has occurred.

4.4 Framework of Study:

The literature survey has revealed:

1. Technology Transfer is a process and is to be looked at in totality, over time.

2. There is need to look at both ends of the transfer process - the source and the user in the context of the environment that is operating when transfer takes place.

3. It is necessary to look at source and user along with the "linkages" linking them.

The overall transfer process can be viewed in combination of Internal linkages, Research Planning and Programme, Infrastructure and Logistics, Finance and Budgetary Process, Personnel System, Evaluation of R and D and external linkages with respect to the user [62]. Internal linkages of the source are basically their structures - structures of policy making bodies and internal structures whereas external linkages are relationship forms of the Headquarter Organisation with the Governmental decision making bodies, of the laboratory with other research organisation and with professional scientific bodies and of the laboratory with its users along with the consultants or any liaison agency.

The framework as used by Mascarenhas in his HMT case and by Shekhar Chaudhuri in his Swaraj Tractor Case is not quite suitable for use in the intended study. In both those cases framework of corporate strategy with focus on <u>management issues</u> has been used. The focus is more on the user of the technology. Compared to that, Gangjee in his study of technology transfer process from ATIRA to textile industry has

looked at the transfer of technology as <u>process</u> with more attention to the source and has finally proposed a sequential transfer process model.

Keeping Gangjee's model in mind the various stages of the study have been designed.

4.5 Stages of the Study:

The stages of the study are given below:

4.5.1 Study of the Environment of the Source and Users:

Chapter I has covered various aspects of the environment such as utilisation of research in India, Govt. sugar policy and its effect on sugar industry.

4.5.2 Study of NSI:

This includes meeting people in NSI and studying published material regarding its history, growth, services offered etc. to gain an understanding of how it functions.

4.5.3 Selection of Cases:

Carefully chosen examples of successful and non-successful transfers of technology were investigated making sure they cover a range of technologies and afford opportunities to talk in-depth with people at NSI and in the industry.

4.5.4 Schedules:

Using the framework discussed already, interview schedules have been developed to cover a large number of technologies and people at NSI and in the industry for gathering insights into the transfer process and the factors influencing it.

4.5.5 Analysis and Conclusion:

The data from interview schedules have been analysed. Tentative relationships that have emerged, have been listed as insights for future examination. Insights gathered from the above stages of the study have been used to construct a model of the transfer process.

CHAPTER V

THE INTERVIEWS

5.1 Introduction:

The rationale behind using interview schedules is that they would allow a structured probing yet not preclude flexibility (by utilising a mix of fixed-alternative and open-ended questions) [63]. Furthermore, face-to-face discussion will allow the researcher an opportunity for taking the respondents back into the time of transfer and allow seeking the help of others who have been present during the period of transfer.

Also, by a detailed comparison of a process of transfer (and non-transfer), it will be possible to identify factors that influence the transfer process. Using those, a model of transfer process can be constructed.

5.2 Areas for Investigation.

From the literature survey it appears that there are som areas which require investigation to understand the process of technology-transfer. These areas are not totally separate fron each other, but there are a lot of interaction among them, duri the transfer process. The nine areas for investigation are listed below:

5.2.1 Origin:

This is basically the history of idea generation. The interest is mainly in how the ideas originate, what are the sources of the ideas and how those ideas get transformed into a research project.

5.2.2 Organisational Factors:

Here factors like interaction pattern among different departments, involvement of people, team-work, involvement of a single person etc. have been probed.

5.2.3 User Characteristics:

User's awareness level, commitment for new indigenously developed technology, decision making body of user, user's size, R and D facility, trial facilities for new technologies have been investigated.

5.2.4 Linkages with Users:

Frequency and medium of communication between user and source, user's dependency on source, etc. have been investigated

5.2.5 Characteristics of the Technology:

Nature, impact, benefit, technical and managerial problem related to the new technology have been investigated.

5.2.6 Preplanning:

Systems for search for user/sponsor, issues like market survey before starting a project, estimates regarding time, money, testing have been

5.2.7 Environment:

Govt. policy, interactions with other related R and D organisations, situation regarding market, finance, labour, power etc. under which transfer has taken place have been probed.

5.2.8 Contract:

Nature of contract/agreement between user and source and how it encourages or discourages the transfer have been investigated.

5.2.9 Attitudes.

Perception of sugar mills vis a vis NSI and vice versa has been investigated.

5.3 Details of Interview Schedules:

Specific questions relating to each of the nine areas highlighted above are listed and grouped together in two separate schedules. (The two questionnaires have been given in the Appendix). The two schedules are discussed below:

5.3.1 Questions to NSI Personnel:

This schedule consists of questions covering all of the above nine areas. During discussion the respondent has been allowed to modify any particular question to facilitate better understanding of the particular technology transfer case.

5.3.2 Questions to the Users:

This schedule also covers all the nine areas discussed already. Broadly the schedule can be divided into three broad categories of questions: a) Questions relating to the particular technology transfer case, b) Questions relating to user's views of NSI and c) Questions relating to the general organisation characteristics of user.

5.4 Order of Interviews:

The first schedule used is "Questions to NSI Personnel". This allowed us to gain familiarity with the specific transfer case, as well as to identify the users for the next schedule.

The second schedule used is "Questions to the users". This is to gather information regarding the particular technology transfer case from the user.

Multiple respondents from both source and users have been used so as to eliminate bias regarding the various factors influencing the transfer process.

5.5 Technologies Chosen for Investigation:

Out of the list of NSI's R and D work over the past three decades, following six technologies have been selected which are of comparatively recent time period. In fact, these are the only technologies over the last 25 years or so about which NSI could claim having reached the user testing stage or beyond.

1. Pre-harvest maturity survey.
2. Extraction of sugar from sugar-beet
3. Sushira: Surface active substance for reducing pol and moisture in bagasse.
4. Manufacture of Baker's Yeast from molasses.
5. Demineralisation of cane-juice by ion-exchange process.
6. Electrical resistance heater for reheating of final massecuite.

5.6 <u>The Sample:</u>

5.6.1 <u>Organisations:</u>

NSI is one category, and users, i.e., sugar mills provide the other category of the sample of organisations studied.

After taking the interviews of NSI personnel it has been clear that out of the six technologies mentioned above, only three may be in use (The other three being blocked by legal problems or corporate strategic factors). The three technologies are:

1. Pre-harvest maturity survey.
2. Extraction of sugar from sugar-beet.
3. Sushira: Surface-active substance for reducing pol and moisture in bagasse.

Four users (or probable users) have been identified for these three technologies. The list of these four sugar mills is given below:

1. Mawana Sugar Works, Mawana (UP) - for Sushira and Pre-harvest maturity survey.
2. Daurala Sugar Works, Daurala (UP) - for Sushira and Pre-harvest maturity survey.
3. Upper Doab Sugar Mills, Shamli (UP) - for Sushira and Pre-harvest maturity survey.
4. Shriganganagar Sugar Mills, Shriganganagar (Rajasthan) - for Extraction of sugar from sugar-beet.

5.6.2 Respondents:

Within NSI, the respondents are all who have been closely associated with the technology in question.

The first contact in the user/probable user organisation is the General Manager or Chief Executive. This is i) to get permission to enter the Organisation and ii) to use his resource for identifying those of his personnel who will make relevent respondents for the interviews. These personnel happen to be out of the following designations:

i) Chief Chemist, ii) Deputy Chief Chemist, iii) Manager (cane) iv) Senior Cane Development Officer, v) Manager (R and D) and vi) Senior Officer (R and D).

CHAPTER VI

THE CASES

6.1 Case 1: Extraction of Sugar from Sugar-beet:

6.1.1 The Technology:

Sugar-beet is used for sugar production in Europe and some middle-east countries where cold climatic condition is not suitable for sugar-cane cultivation. There are also some distinct advantages of using sugar-beet as raw material of sugar - i) sugar recovery is 13% , compared to 9 - 11% in case of sugar-cane, ii) it is a short duration crop. It takes 5 - 6 months whereas sugar-cane takes 12 months, so growers can get two crops a year, iii) the by-product of the process, beet-pulp, can be used as a cattle-feed, iv) another by-product beet-molasses, can be used as the raw material for manufacturin vitamin B-12 commercially.

Unlike sugar-cane juice extraction where juice is extrac by crushing sugar-cane in crushing mills, juice can be obtained from sugar-beet by diffusion process. Sugar-beet is cut into very small pieces and then water is added to it. Then under proper temperature and after 1-2 hours agitation juice containing sugar and non-sugars comes out from sugar-beet pieces by diffusion process which is then used for manufacturing of sugar

6.1.2 The Stimulus.

Dr. Rajendra Prasad our first President, while on a visit to USSR in 1955-56 first got interested in cultivating sugar-beet in India and Dr. Rafi Ahmed Kidwai, the then Central Agricultural Minister took the initiative of looking into the feasibility of the idea. Indian Institute of Sugar-cane Research, Lucknow was entrusted to look after the agriculture aspect of the project whereas NSI was given the responsibility of the technology of producing sugar from sugar-beet in 1959.

6.1.3 Sriganganagar Sugar Mills:

Shriganganagar Sugar Mills of Rajasthan started as a private undertaking in 1945 solely depending on sugar-cane as raw material. But due to non-availability of adequate amount of sugar-cane in that region the owner closed the factory in 1955. On the request of workers and the sugar-cane growers, the Rajasthan Govt. took over the factory in 1955-56. But the mill continued to make heavy losses. Meanwhile, the interest in sugar-beet had been generated during the President's foreign visit. To start with, the Director of NSI, suggested using sugar-beet in addition to sugar-cane to elongate the crushing season at Shriganganagar.

6.1.4 Trials, Result and Implementation:

In 1960, first trial was conducted at NSI. But due to excessive foaming, juice got spoiled and till 1964, no further trial was undertaken. In 1964, Dept. of Food told NSI to take up the project again. NSI imported a 25 tonne Danish pilot plant, along with know-how. Trials were conducted in 1964 at Yamunanagar (Haryana), next year at Bhogpur (Punjab), then at Shriganganagar and Daurala (UP), by using the same pilot plant. By conducting these trials, NSI was able to standardise various process parameters like temperature, duratio etc. to adapt to Indian conditions. But as climatic condition was not suitable for sugar-beet cultivation at Haryana, Punjab and UP and due to sufficient availability of sugar-cane in those areas, production of sugar from sugar-beet did not seem to be feasible in those areas. In the case of Shriganganagar, as sug cane gets exhausted by February, sugar-beet can be used in March and April (after which, due to excessive heat sugar-beet deterio rates very fast). So Shriganganagar ultimately took up the technology of producing sugar from sugar-beet. In 1969-70, Lars and Toubro, the agent of the Danish Diffuser Company supplied a 600 tonnes diffuser with some indigenously fabricated components and since then sugar is commercially being produced from sugar-beet at Shriganganagar.

6.1.5 Govt. Assistance:

Rajasthan Govt. has allotted the required extra-amount of water (2o Cusec) to the sugar-beet cultivators at a reduced rate. The sugar mill has also guaranteed the growers that all their crop would be bought by the mill. National Seed Corporation with a nursery in Kashmir, is supplying the seeds to growers. Very recently, due to heavy snow-fall most of the seed got destroyed at the nursery and against a yearly requirement of 120 quintal only 40 quintal of seed was available. The short-fall was made-up by importing seed from Belgium at a very high cost (Rs. 5200/- Kg. against NSC rate of Rs. 30/- per kg.). The sugar-mill has paid the extra amount from its own fund so that the growers did not get disencouraged.

One notable result of this commercially successful project is that the sugar-beet molasses is being used to manufacture Vitamin B-12 by a Bombay firm who earlier used to import the raw material for making Vitamin B-12 at an exorbitant price.

6.1.6 Inadequate Commercial Performance:

But inspite of this, Shriganganagar Sugar Mills is still making losses from its sugar unit, though overall they are making profit through their distillery operation. NSI in its initial report estimated that the sugar recovery would be around 13% , but it has never crossed 11% because the seed could not be totally adapted to Indian condition. Indian

Institute of Sugar-cane Research, Lucknow is still working on the problem.

In the mid 1960's, after successful completion of pilot plant running there was a proposal to set-up a sugar mill in Kashmir totally based on sugar-beet. But because of high transportation cost of fuel the proposal was dropped. As it appears, there is virtually no chance of sugar-beet being used widely as a raw material for sugar production in India in near future.

6.2 Case 2: Pre-Harvest Maturity Survey:

6.2.1 Introduction:

The total soluble solids including sucrose present in the cane juice is measured through testing of brix. Brix has definite relationship with sucrose content in the juice. The use of hand-refractometer in measuring sucrose content in Brix in India was reported in 1934. NSI took-up the project in mid 1930's when the institute was first established. Research at NSI helped to standardise the Field Brix Method which was the "simplest, cheapest, most practical and fairly correct" way to evaluate cane maturity under Indian condition as claimed by NSI.

6.2.2 The Method:

In this method, small amounts of cane-juice are extracted from clumps in a sugar-cane field. The juice is taken from middle internodes of the canes of a clump by a specially

6.2.4 <u>The Prevailing System of Cane Supply</u>:

Cane was supplied to the factories on "equitable distribution basis" through the cane cooperative societies of the cane growers. Average supply of a cane grower during the last 3 or 5 years was accepted as the standard quantity of sugarcane for him and he used to supply the cane to the factory after receipt of harvesting challan on equitable basis. This system for cane supplies had the following disadvantages (from Sugar Mills' point of view):

i) As the payment was made entirely on weight basis, so there was no surity of the sugar mill getting the best crop.

ii) A large number of harvesting challans were issued three days in advance and it used to become difficult to control the cane supply in the event of break-down.

The maturity survey tended to relieve these problems for the mills.

6.2.5 <u>Reaction and Modification</u>:

When the pre-harvest maturity scheme was introduced, some growers, whose crop matured late, had to wait long for the harvest. This caused some resentment. So the system of cane supplies under maturity system was modified. The sampling technique was studied afresh, chances of error during maturity

testing were removed and the modified scheme was introduced on experimental basis at Lord Krishna Sugar Mills, Saharanpur during 1968-69 season. Most of the practical difficulties encountered earlier were over-powered and the results were shown practically to the State Government officials and factory authorities.

Under the modified scheme some of the aspects of equitable basis were retained. Growers having higher Brix cane fields than the optimum were given 50 percent extra harvesting challans in the first month of the season than what actually he was entitled to as per the equitable basis. Similarly, 50 percent harvesting challans were given less to the growers having lower brix fields. The increase/decrease of harvesting challans was adjusted during the second month. Though this was not strictly maturity-wise cane supply, but had very encouraging results with least opposition from cane-growers.

6.2.6 Diffusion:

Many factories started approaching NSI for taking up this new technology. As it was not possible to guide so many factorie at a time, 10 sugar factories were selected for providing guidan in adopting maturity-wise cane supplier in 1969-70. Performance of all sugar factories was good. Results at two Western UP factori were exceedingly good [One recorded the highest sugar recovery of 11.79 percent in northern states whereas the other stood second with 11.41 percent]. 6-8 factories were guided every year

in adopting the system till 1975-76 in UP, MP, Maharastra and Karnataka. Increase in sugar recovery was noticed to be 0.5 to 0.8 percent. There were other advantages also, like, increase in cane yield, better juice quality with less manufacturing loss and higher juice percent cane throughout the season.

During 1975-76, UP Govt. requested for fair trial of the system on a large scale under the control of the State Cane Commissioner. NSI carried out the trials in about 2.0 lakh hectare cane area in 23 sugar factories in UP. NSI arranged for proper training and education for the field-staff and cane-growers. On account of maturity-wise cane supplies in these factories, sugar recovery increased by 0.3 - 0.8 percent. Those 23 factories produced 18,000 tonnes extra sugar because of this scheme as against extra cost of Rs. 18 lakhs including man-power and equipment. Encouraged by this,32 sugar factories in Haryana, MP, Gujarat, Karnataka and Maharastra have adopted the system under technical guidance of NSI in 1976-77. Short duration courses were also arranged at Pune, Coimbatore, Patna, Gorakhpur, Meerut, Bareilly and Sameerwadi (Karnataka) during 1977. About 100 factories in the country adopted the system during 1977-78. Development council for sugar industry met under the Chairmanship of the Food Secretary, Govt. of India at New Delhi and asked the ISMA and National Federation of Cooperativ Sugar Factories to adopt the pre-harvest maturity testing technique for sugar cane under the guidance of NSI.

6.2.7 Limitations of the Technology:

Some mills believe that the survey does not ensure the best cane for the mill, because the grower after the survey sends his best cane to gur and khandsari makers. A more serious limitation is the logistics of surveying so many growers. Some mills have therefore discontinued the scheme.

Still there are approximately 200 sugar mills in our country using pre-harvest maturity survey for cane supplies and there is no doubt that this is the case of one of the most successful technology transfer from NSI.

6.3 Case 3: Sushira -- Surface Active Substance for Reducing Pol and Moisture in Bagasse.

6.3.1 The Technology:

The bagasse after extraction of juice still contains 3 to 4 percent of pol (sugar) along with other non-sugars as present in cane-juice. This bagasse is also wet and has about 50 percent moisture which restricts the fuel value of the bagasse which is used in boiler.

In 1975, a researcher of NSI got an idea of reducing pol and moisture in bagasse from some foreign chemical journals and noticed the application of the same principle in leather and textile industries.

Surface active compounds normally break the surface tension and so they develop many properties like wetting properties, detergency, diffusion and enhance the absorption etc. Surface active substances are used as wetting agents in textile and leather industries so that water can go deep into cotton or leather and proper dying and bleaching are possible.

These compounds can be classified into three groups: i) Natural, organic, ii) Natural inorganic, and iii) Synthetic. The surface-effect of some substances are individually low and specific. In actual application where a variety of substances has to be handled and as well as either wetting property or absorption or detergency is required, then instead of a single surface-active substance two or more surface-active substances are used. The principle of synergism specifies that when two surfactants are mixed in an optimum ratio the sum total of the surface-effect is more than the added individual effect. This principle was applied to find out a chemical for reducing pol and moisture in bagasse.

Two chemicals were mixed in fixed ratio - one is an Ester of Alkyl-sulphosuccinate and the other is an Alkyl-aril Sulphonate and the mixture in optimum ratio is known as Sushira.

6.3.2 Development and Trial:

The researcher made a formal proposal for R and D for this technology in 1975. The project proposal was approved in 1975 itself and the feasibility of the project in lab. was also established in 1975. A reduction of 0.6 - 0.8 percent of pol . and 2 percent of moisture in bagasse were observed.

Through NSI's official circular and NSI bulletin the industry became aware of the availability of the technology and four sugar mills - all in Uttar Pradesh, approached NSI for trying it out at their own mills.

In the meantime, NRDC gave the patent of this chemical to NSI in 1976 and NRDC gave license to four manufacturers in 1977 to produce the chemical. Two manufacturers were in North India, one each in Maharastra and Andhra Pradesh.

During 1976 to 1978, the sugar mills conducted trials with the help of NSI staff at their own cost. Initially Sushira evoked a lot of hope because as claimed by NSI it promised to increase sugar recovery as well as to reduce moisture content of bagasse for better boiler efficiency. Two chemists of a sugar mill documented and appreciated the use of the chemical in a technical journal.

6.3.3 The Failure to Transfer:

However, no sugar mill took up this technology for commercial use. Chemists and R and D scientists of two mills

said that the claim of reduction in pol and moisture in bagasse by using Sushira was not correct. Bagasse is a heterogeneous substance and its moisture and sugar content depend on environmental conditions as well as various parameters of the whole process from initial to final milling of sugar-cane. The huge quantity of bagasse (30 tonnes/hr. for a 4000 tonnes crushing per day mill) also makes the determination of a representative sample of bagasse for measuring pol and moisture very difficult. According to the chemist of a sugar mill, Sushira converts the sugar of bagasse into water and carbon-di-oxide. So the bagasse pol gets reduced but that reduction does not get reflected into increased sugar-recovery.

The sugar mills could not be convinced about the effectiveness of Sushira. Perhaps, the absence of an established and well proven method of measuring retained pol and moisture of bagasse resulted into the failure of Sushira of being a successful case of technology transfer.

6.4 Case 4: Manufacture of Baker's Yeast from Molasses:

6.4.1 The Technology:

Manufacturing Baker's Yeast from molasses was a well-established process in the Western Countries. In India, a multinational was making Baker's Yeast from molasses in collaboration with a British Distillary before NSI started working on it. The Joint Secretary of Sugar who was also the Chairman of Modern Bakeries, got interested in acquiring indigenous know-how

for production of Baker's Yeast from molasses around 1950-51 for usage in the bakeries. Being cheap molasses made the cost of manufacture of Yeast very low. But the foreign collaborators were charging quite high, so unless indigenous know-how was developed that advantage got nullified. Once, the bureaucrat left, the idea went into cold-storage for a long time.

6.4.2 Diversification of a Sugar Mill:

The Proprietor of a sugar mill in North U.P. was looking for know-how for production of Yeast from molasses in mid 1960s. Being situated in a backward area, the mill was entitled to get soft loan from Govt. for developmental work. The mill owner wanted to utilise that loan for diversification into production of Yeast which was having good market demand. He first approached some European countries, but their types of collaboration agreement were not quite suitable in terms of cost and then he came to NSI. The mill sponsored the project at NSI in 1968. The sponsorship was more of the nature of collaboration on advisory basis as NSI was not supposed to enter into direct sponsorship with outside party.

6.4.3 Development of Process:

One critical recruitment was done in 1968 itself. Purchasing of critical equipments was completed in 1969. First NSI developed the process in its own lab. and by the end of 1969 successful trial was conducted at the sugar mill. Apart from the Yeast

centrifuges all the other equipments were indigenous in nature. By March, 1970, pilot plant started functioning at the sugar mill and the process got standardised.

6.4.4 Commercial Production.

Full scale commercial run started in March, 1971. NSI got patent for the process in July, 1972. All this time, NSI personnel were going frequently to the sugar mill to establish the process and to train the people there. Though the size of the Yeast producing plant was much smaller (0.5 tonne/day) compared to the multinational's plant in Bombay (20 tonne/day), still the multinational found it difficult to compete with the sugar mill which was marketing the product at a much lower price.

6.4.5 Setback and Closure:

But in 1973, the project suffered a set-back. Two persons of NSI who were very much involved in the development of the process and who were at the sugar mill for debugging the process and training the people there went abroad in 1973. Once they left, there was a shortage of people well conversant with the process and the sugar mill owners lost their interest in continuing with the production of Yeast. By the end of 1973 the plant stopped functioning. In 1975, that got converted into a plant for making another chemical. But after one year even that stopped functioning and the plant was scrapped in due course.

This was a case of a technology transfer where after the commercial run started, suddenly the plant was stopped and the technology developed by NSI went back to cold storage.

6.5 Case 5: Demineralisation of Cane Juice by Ion-Exchange Process.

6.5.1 The Problem:

In the cane juice along with sugar, non-sugars are also present to the extent of 2-3 percent. Some of these non-sugars are non-crystalisables to the extent that they increase the solubility factor of sugar and thereby hinder crystalisation of sugar out of cane-juice. Because of this, the final molasses after recovery of sugar still contains 33 - 35 percent of sugar. The loss is approximately 0.9 to 1.2 percent of cane. Presence of these non-sugars gives rise to colours which are originally present and are also formed during processing of sugar due to complex formation and caramelisation of sugar (non-sugars burn with presence of acidic material and form black charcoal) and destruction of sugar. The complex is formed due to interaction of degraded sugar and amino acid and nitrogenous substances present in the juice. Net result of presence of non-sugars is low sugar recovery and poor quality.

6.5.2 Advantage of Demineralisation:

Demineralisation removes non-sugars and colouring materials which result into higher yield, i.e. an increase of about 0.7 to 1 percent in sugar output and better whiter sugar with a better keeping quality.

The syrup which is obtained after sugar is recovered from demineralised cane-juice contains only sugar, traces of edible minerals and fit for direct human consumption.

6.5.3 Project Initiation, Team and Supervision:

The idea for this new technology originated in 1954 from some foreign and Indian literature and initial work started simultaneously at NSI and National Chemical Laboratory (NCL), Pune. NCL was very much interested in the project, and Govt. thought it would be better to continue the research at NSI as the facilities were available there. The project got approved at NSI in 1955 and the sponsorship with NRDC was finalised in 1955. NRDC provided all sort of financial support for the project. Director, NSI, was the Working Head of the Project Team. The progress in work was regularly checked by a Board selected by NRDC. Director, NSI, had to report to the Board about the progress made as well as to the Advisory Board of NSI. Staff employed in the scheme were under the employment of NRDC. Senior scientists of NSI who were involved in the project were coordinating and supervisory staff.

6.5.4 Research:

All the critical recruitments were completed by April, 1956, and the critical equipments like Evaporator, Condenser, Boiler arrived by June, 1958. In the meantime the feasibility of the initial idea had been established by successful completion of

research work in the lab. at NSI in 1957. The plant and equipments necessary for pilot plant running were available at NSI and the first pilot scale trial was conducted in 1959. Using the results of this, the whole process was streamlined.

6.5.5 Communication:

Through NSI's official circular, bulletin and STA seminar the industry became aware of the technology and some of them contacted NSI for conducting trial run at their factories. Factories in different regions were selected for trial purpose to test the feasibility of the process for sugar-canes of differ regions.

6.5.6 Trials:

During 1961 - 62, trials were conducted at five mills, four in North and one in South India. The trials involved capital investment and high operating cost. During this phase, NSI personnel visited the factories 3 - 4 times for conducting trials. The sugar mills got convinced about the feasibility of the process but they were not ready to commit themselves into capital investment. Only one sugar mill in Maharastra showed interest but ultimately they also backed out due to financial problem. So though the process was patented by NRDC in 1965, no factory was using it.

In 1964, NSI published the work in a foreign journal. An American Company picked it up and established the process and

sold the process to two factories in Italy around 1970-71. Though the process was basically the same as established by NSI, the American Company conducted trial on the life of the resin used for demineralisation purpose which had not been done by NSI and they established the specification of resin for desired life period.

In 1974, a cooperative sugar mill in Maharastra approached NSI for conducting trial of the process at their factory. Part of the Pilot Plant which was already there at NSI was lifted to the sugar mill. Testing of resin (both indigenous and foreign) was also conducted. The mill did not consider the technology to be commercially attractive enough. They requested the Govt. to exempt them from excise duty on the molasses and import duty on the imported resin, and to exempt them from levy on the extra sugar produced.

Govt. did not agree. Govt. view point was that the extra sugar recovery did not warrant those concessions. Nevertheless, Govt. formed a committee to look into the issue in 1978, but the concessions asked by the mill are still under consideration, and the mill is not using the process.

6.6 Case 6: Electrical Resistance Heater for Reheating of Final Massecuite:

6.6.1 Initiation:

Massecuite is the heterogeneous mixture of sugar crystal and molasses from which the sugar crystals are recovered.

Massecuite is heated by indirect heating but it results into non-uniform heating of massecuite. An Engineer at NSI thought of passing electrical current through the massecuite and thereby heating it by resistance heating, He conducted the trials during 1956 - 58. In lab. scale the trial was very promising. At the same time in Australia also scientists were working on the same problem. But the Australian Scientists and NSI could not be successful in getting a commercial scale model.

6.6.2 Commercial Scale Model:

In 1974, the problem was again taken up in NSI as there was demand from the industry regarding the commercial model of the electrical resistance heater. An engineer tried to make a commercial model and he also could not be successful. He left NSI after that and his incumbent took up the project. It took around one week to complete fresh lab. scale trial and generating data thereof for making pilot scale model. A sugar mill from Maharastra approached NSI for conducting pilot plant trial at their factory. NSI sent their staff there and the mill bore all the costs for trial. The trial was very successful. It took around 6 months for moving from lab. to commercial scale model. A manufacturer of sugar industry machineries got convinced about the equipment and asked for a license to manufacture it. They were told to contact NRDC, as NRDC is the agency for issuing patents and licenses for products/processes coming out of Govt. controlled R and D units.

6.5.3 Legal Problem:

At that time the engineer, who was earlier involved in the project, also applied for a patent. Patent office rejected his application and he moved to Allahabad High Court. The case concerning the ownership of patent of the equipment is still pending in the High Court and till the court gives its decision, the technology cannot be used.

This is a case of un-successful technology transfer where the transfer process stopped due to legal tangles.

CHAPTER VII

ANALYSIS OF THE CASES

7.1 Introduction to the Analysis:

From the cases of Chapter VI and from the interviews, the issues influencing the transfer process have been analysed in this chapter. No undue generality is implied in the analysis. Six cases merely provide some insights which may be subjected to further scrutiny.

7.2 Analysis:

7.2.1 Origin of the Technology:

(i) Source of the Technology:

The ideas of the technologies usually originated from articles published in foreign literature.

(ii) Stimulating Factors:

In case of the two technologies which ultimately reached regular commercial use, the Govt. provided the stimulus in terms of idea generation and/or encouragement and utilisation of the technologies.

The project of 'Beet-scheme"was initiated when one important Govt. functionary initiated the idea of manufacturing sugar from sugar-beet after seeing it in some foreign country.

In later stages Govt. provided encouragement in terms of permitting import of pilot plant, initiating research at NSI and Indian Sugar-Cane Research Institute and granting permission of usage of extra amount of water to the sugar-beet cultivators from the Rajasthan irrigation canal.

In the other project, i.e."cane maturity survey," Govt., through Cane-Commissioner and Cane Development Officers, revitalised the project. They encouraged the potential user-mills to take up the technology and NSI was also encouraged to modify the scheme to suit the existing cane purchase procedure.

In another two projects,"Baker's Yeast"and"Demineralisation of cane-juice," though ultimately the technologies were utilised with only partial success, the initiation was through Govt. agencies - the Department of Food and NRDC respectively.

The sugar-mills also contributed to the initiation process Whether the technology was ultimately utilised or not, the sugar mills participated in the idea generation stage by conveying their needs to NSI and in many cases led to revival or restarting of the project work in later stages.

(iii) Foreign Provenness:

Three technologies, that found commercial usage, were proven technologies in foreign countries. These are "Extraction of sugar from sugar-beet,""Cane-maturity Survey" and "Baker's Yeast". They were in commercial use in a large scale in many

developed countries. The NSI was mainly involved in adapting the technologies in Indian condition and necessary modification and standardisation of the process or equipment.

"Sushira" and "the ion-exchange process" had no foreign credentials. Unfortunately, both are yet to be commercialised in India.

7.2.2 Continuity of Research Team:

The research teams usually consisted of 2 to 3 scientists and they were headed by competent senior scientists having Ph.D. degree and experience in their field. Most projects had lasted over a decade (with intervening lulls). However, there had usually been a continuity of membership in the research teams.

7.2.3 Linkages with the Users.

(i) Relation between NSI and Industry:

NSI and the sugar industry are very close to each other. Most of the senior technologists working in the sugar mills are former students of NSI and NSI through its extension and advisory services have maintained good contact with the users. The annual STA seminar is also held under the patronage of NSI which also facilitates maintaining a good relation between NSI and users and a mutual feedback process.

In the areas of technical competency, openness to new technology, being up-to-date with latest in sugar technology field, cooperativeness, positive attitude towards new developmental work, as investigated during the interviews, both NSI and the industry have good opinion about each other in general.

(ii) Mechanism of the Linkage:

Extension and advisory services form the basic linkage of NSI with the industry. Conducting trials at sugar mills and imparting training to the user staff form an important part of the extension service provided by NSI to the industry. However, in order to sponsor research at NSI, the industry has to go through the NRDC/Govt. of India which naturally complicates the linkage.

(iii) Mills' Willingness to Try Technology:

In all the cases, investigated in this study, after the bench-scale-trials were completed at lab., the mills extended their facilities for pilot plant trial in terms of money, manpower and equipment, though, in many cases, it did not lead to commercial utilisation of the technologies.

In the case of "Pre-harvest maturity survey scheme", trials were conducted in more than 150 mills and most of them had ultimately taken up the technology for usage.

Four mills were selected by NSI at four different regions for conducting trial for manufacturing of sugar from sugar-beet after they showed their interest in it and one mill finally

took up the technology.

The project of "Manufacturing Baker's Yeast from molasses" was initiated when one sugar mill expressed its willingness to use this technology and after successful completion of pilot plant trial they used it also for a couple of years.

"Sushira", "Ion-exchange process", "Electrical resistance heater" - these technologies were also tested at various sugar mills, though ultimately that did not result into their commercial usage.

(iv) Trialability:

In three of the technologies of NSI, the trials in general did not involve heavy cost and did not pose any threat to the sugar mills' output quantity and quality. However, in the other three cases this was not true. In case of "beet-scheme" the pilot plant was imported by NSI and was used at various mills as a separate unit.

The trials of ion-exchange process also involved heavy capital investment. The production of "Baker's Yeast from molasses" posed some threat to the product during trial stages.

(v) Process of Communication:

NSI staff and industry communicated through frequent visits to each other during pilot plant trials and commercial production stage.

(vi) Training.

During pilot plant trials and also when the commercial production started, NSI personnel were available for imparting training to the user staff. None of the technologies were noted to have failed for lack of user training facility.

7.2.4 <u>Impact of the Technology:</u>

(i) Pay-Offs:

As far as the pay-offs of these technologies were concerned "Beet-Scheme","Maturity-survey", "Sushira" were meant to increase the sugar <u>output</u>, though in case of "Sushira", the sugar mills did not agree with this view-point. Whereas "Electrical Resistance Heater" was to satisfy the process-demand of uniform heating of the massecuite for better <u>quality</u> sugar, "Ion-exchange process" meant to improve both quantity and quality of sugar.

"Manufacturing Baker's Yeast from molasses" resulted into <u>utilisation of the by-product</u> as well as import reduction of Yeast.

The molasses obtained from sugar-beet also resulted into <u>saving of foreign exchange</u> as it could be used for manufacturing vitamin B-12, the raw material for which was being imported earlier.

(ii) Investment and Cost:

Of the six technologies investigated, for three technologies a need was perceived to add new facilities. "Extraction of sugar from sugar-beet" involved setting up a totally new plant as it was a different process of making sugar altogether. "Manufacturing of Baker's Yeast from molasses," also involved adding new equipments for converting the molasses, a by-product of sugar manufacturing process, into Yeast. "Ion-exchange process, was basically an additional process for increasing sugar recovery and betterment of quality and it also required adding of new facilities and the use of imported ion-exchange resins.

"Electrical resistance heater," though asked for some capital investment, was to replace the old-designed existing heater.

For "Sushira" and "Pre-harvest maturity survey," there was minor increase in operational cost and the users and potential users also agreed with NSI on this point, as revealed during the interview stage.

(iii) Managerial Impact:

This aspect was investigated only in the case of two technologies being used commercially at present, viz., "Beet Scheme", and "Maturity - Survey."

In case of "Beet-Scheme" the user mill did not find any managerial or administrative problem during or after the commercial implementation of the technology.

In case of "maturity survey", two user mills observed that during the introduction of the scheme they faced some resistance from the cane-growers as it involved in some modification of the existing cane-purchase procedures, but later it was well accepted and they did not face any sort of problem. Another sugar-mill after using the scheme for eight years, discontinued it as they found it difficult to manage it with more than 40,000 growers.

7.2.5 Environmental Influences:

(i) The Influence of Government:

The most important of the environmental factors to influence transfer process was noticed to be the Govt. influence.

In case of "Beet-scheme" and "Baker's Yeast" the initial work started after Govt. showed interest in them. In case of "maturity-survey scheme," the transfer really became successful only **after** Govt. started taking active participation through Cane Commissione and Cane Development Officers in convincing the sugar mills and the cane-growers about the pay-offs of the technology.

The project of "ion-exchange process" was allotted to NSI because Govt. felt that NSI would be the best place for the R and D work of this type.

Apart from these direct influences, Govt. has overall influence through a number of controls on this industry. The general sickness prevailing in the industry and the reluctance on the part of the potential users in committing heavy capital

investment for modernisation and developmental work has been alleged by many to be a result of Govt. policy of control, sugar release, total control of molasses etc.

Govt. for the first time introduced partial decontrol from 1965-66 season after an era of total control of sugar. We find that two R and D projects of NSI were restarted or commercially used soon after the new policy took effect. That is, the industry, in 1968-69, started to show rigorous interest in "pre-harvest maturity survey." The project on "Baker's Yeast" also restarted from 1968.

(ii) Effect of High Production:

In response to the partial decontrol policy of Govt. as announced in 1965-66 season, the production has maintained a growth trend barring the seasons of drought and flood. Higher capacity utilisation of the industry (in 1974-75 it was 104%) resulted into need of technology for higher quality and value added. It is noticeable that the work on "ion-exchange process" restarted after a long gap in 1974, and the work on "Electrical Resistance Heater" was also retaken in 1974.

(iii) Market as a Constraint:

The domestic market could not keep the pace with increasing production. The industry, in general, really could not come out of the sickness due to sluggish market and though initial interests were shown by many sugar mills, ultimate taker of the technologies were few in number and mainly restricted to a few big sugar mills.

(iv) Financial Condition:

As already discussed in Chapter I and under the preceeding sub-headings, the general financial condition of the sugar industry is poor. It has a very important bearing on the poor utilisation of the indigeneously developed technologies. It can be seen that out of six technologies investigated, two are commercially successful, one has been rejected by the industry, one has been stalled by legal proceedings and for the other two there are no takers.

7.3 Summary of Analysis:

In this chapter, the issues influencing the technology transfer process from NSI to the sugar mills which have emerged during the course of the study have been investigated.

We found that most technologies have emerged from foreign articles but the successful ones were those with proven foreign track-record. Apart from this, the Govt. and the industry both have played the role of stimuli in the case of successful transfer processes.

We have also found that there is reasonable communication and good relationship between NSI and industry. There also appears to be mutual willingness to give technology and to try technology.

While deciding on whether to take a technology, as expected, the potential users, stress entirely on the techno-economic

aspects rather than on aspects like leadership in the industry etc. Being of simple nature, the technologies after adoption have appeared to create almost no administrative and managerial problems for the user mills.

As sugar-industry has considerable Govt. control, Govt. policies have affected production, market situation, financial condition of the industry and thereby the mills' ability and willingness in investing in developmental work and modernisation. It has been found that Govt. policies regarding control and decontrol of sugar had direct repurcussion on the increased capacity utilisation of the mills and thereby arousing the industry-need regarding processes or equipments which would guarantee improved quality and quantity of sugar at a lesser manufacturing cost.

CHAPTER VIII

CONCLUSION

8.1 Insights from the Analysis:

Given below are the insights that emerged from the analysis as given in the previous chapter.

1. Ideas of new technologies usually generate from articles published in foreign literature.
2. The technologies already proven in foreign countries are more likely to become successful transfer cases.
3. Government involvement in an R and D project from beginning helps in successful transfer.
4. User mills decide on adoption of technology on the basis of purely objective factors rather than on aspects of prestige, industry leadership etc.
5. User mills' decision to adopt technology is linked with (a) govt. policy on the sugar industry, (b) the domestic demand-supply condition in the sugar market, and (c) the financial health of the mills,

8.2 A Process Model of Technology Transfer:

8.2.1 Introduction:

Combining the insights gained from the analysis and the literature on technology transfer models, a model is proposed that focusses on the transfer process in the context of various background factors.

8.2.2 Description of the Model:

The model depicts the various stages in the transfer process. It must be made clear that these stages are conceptual classifications made in order to highlight certain aspects important for transfer. The context within which transfer is occurring has its own influencing factors.

The proposed model is an elaboration of the basic "Sequential Adoption Model" [62] discussed earlier in Chapter III (Fig. 4).

In the proposed elaborated model, shown in Fig. 5, the first stage, i.e., idea generation stage at the Govt. controlled R and D lab. is influenced by the Govt. controlling agency, foreign and Indian literatures and need of the industry.

The next stage, project finalisation, basically involves the preliminary feasibility study, estimates etc.

After the formation of project team and purchase of critical equipment, R and D work at lab. starts.

Once the feasibility is established in bench scale, the industry, as a whole, becomes aware of it through official circular, journal, seminars, personal letters etc.

Then various interested mills conduct pilot plant running with the help of the source R and D lab.

If the new process/product/equipment needs any patenting or licensing, NRDC gets involved. NRDC is the linkage with any

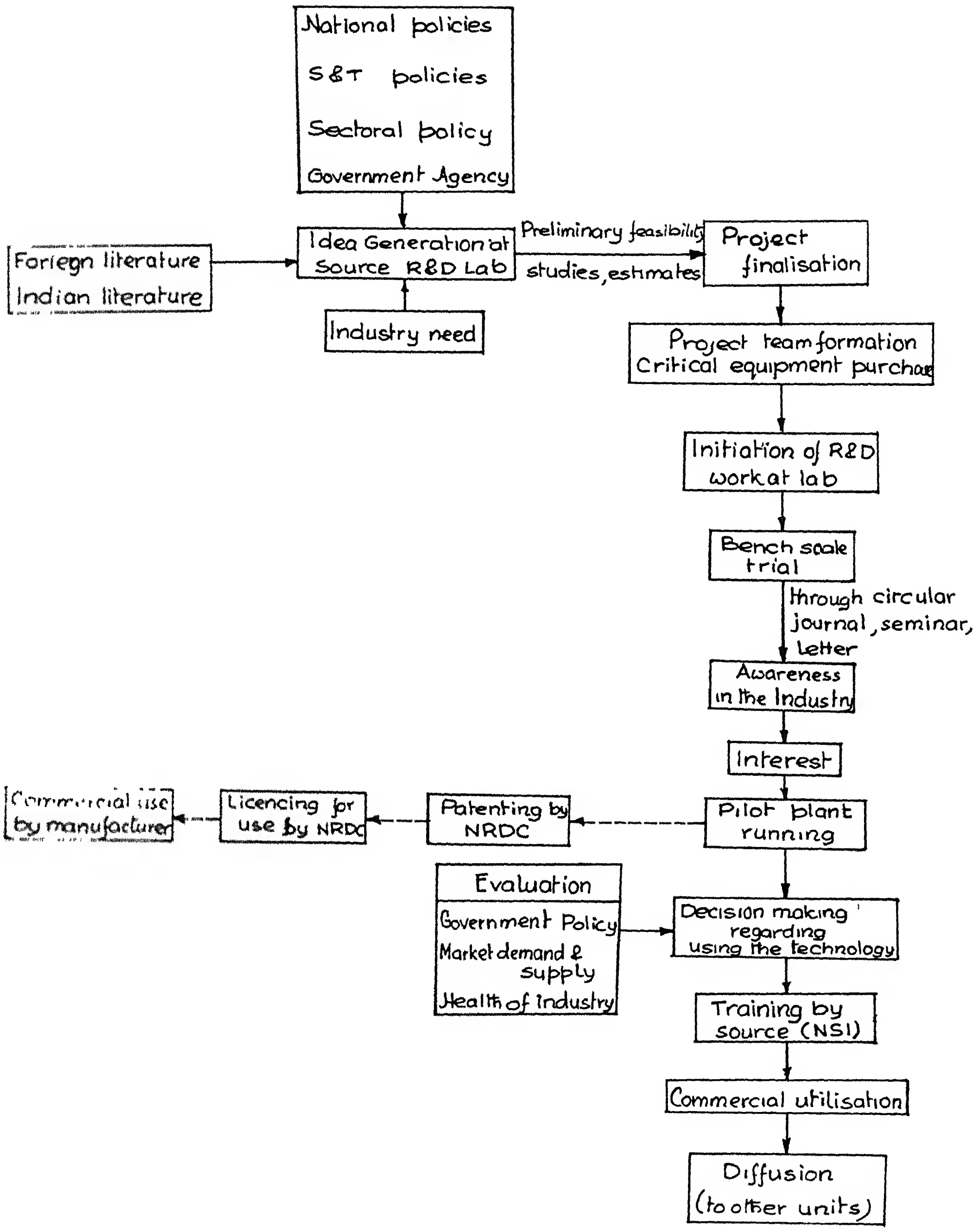


Fig.- 5

PROPOSED MODEL FOR THE TECHNOLOGY TRANSFER PROCESS
(Based on study of National Sugar Institute)

third party, who may be the manufacturer of a product or equipment to be used in the particular industry.

Then the decision of commercial run is taken by the potential user which is influenced by various environmental influencing factors including Govt. influences.

Once the decision is taken about utilisation of the technology, help is sought from the source (NSI) for giving training to the user staff and the commercial run commences thereafter.

The last phase is Diffusion, which is basically the spread of the usage to other mills.

5.2.3 Discussion of Model:

The basic (sequential adoption) model has depicted the various stages one organisation has to undergo during the adoption of a new technology. That is, the focus is on the adoption process of the user organisation. On the other hand, the proposed model has tried to look into the technology transfer process with a view of totality i.e., the focus is on both the source and user.

If the two models (the basic Sequential Adoption Model and the Proposed Model) are compared, it can be found that the basic model has not dealt with the stages in between "Need" and "Awareness", whereas the proposed model has incorporated those stages, which are basically the concerns of the source - in this case NSI, a Govt. controlled R and D lab. These stages like

Project Finalisation, Project Team Formation and Critical Equipment Purchase, Initiation of R and D work at lab. and Bench Scale Trial - are within the boundaries of the source with almost no influence from the users, as can be seen from the cases and the analysis.

The industry need"as depicted as the first stage of the sequential adoption model, has been viewed in the proposed model as one of the influencing factors for the first stage of the proposed model, i.e., the idea generation stage along with other factors like National S and T policies, Sectoral policy, Foreign and Indian Literature etc.

Another major difference between these two models is the positioning of the Deliberation/Decision Making/Evaluation process. In the basic model "Deliberation" is done before trial and then is the "Evaluation" stage. Whereas in the proposed model the deliberation process occurs at various stages. There is deliberation by source before accepting project proposal, deliberation by the prospective user before allowing pilot plant testing, deliberation on full-scale adoption etc. Hence, the proposed model does not make any specific mention of "deliberation" stage.

In the proposed model, in order to get a clearer view, the stage of "adoption"has been split up into two phases - Training by NSI and commencement of commercial utilisation of the new technology.

The last stage of the basic model, i.e., "Integration," has not been incorporated in the proposed model. In the case of NSI-technologies which ultimately found commercial use, we discovered that there has not been much impact of the technology on the administrative and managerial aspects of the user mills. Therefore, the stage of "Integration" has not been considered.

The Technology Transfer Process can be extended to the stage of "Diffusion," i.e., spread of usage to other mills as has been found in the case of "Pre-harvest maturity survey scheme". Many sugar mills started using this scheme after encouraging results were shown by the mills who were already using it.

Government has considerable direct and indirect influence on the sugar industry. The generation of new ideas for Technology and the industry's decision to adopt these ideas are naturally affected by Govt.'s prevailing policies.

Also, NSI is a Govt. controlled R and D lab., Govt. influences the idea generation stage as well as the working at the lab itself through the administrative and financing linkages. These dominant and frequent roles of the Govt. reflect in the model which is markedly different from the usual Sequential Adoption Model.

The entry of NRDC into the TT process, for the patenting and licensing of technologies, also causes a major feature of the proposed model.

8.3 Recommendations for Better Technology Transfer:

The analysis of the cases gives an indication of what can be done to facilitate Technology Transfer.

Technologies may originate anywhere but should be checked against users' need at the start of R and D work. This would involve identification of potential users, environmental forecasting for the proposed period of commercialisation and help ensure the discipline of estimating non-technical factors realistically.

The pay-offs from the technology should be carefully spelled out for the users to take into account when making their decision. Whilst doing this, NSI should be aware that users do not seem to think that enhancing their prestige is a reason for accepting technology. Users seem to want technologies that better the quantity and quality of product and decrease cost of raw material.

In order to improve the adoption rate of technologies, for every technology being transferred there must be a formal list of preferred user characteristics - technical and managerial- to be used as criteria before deciding the mills for conducting trials. As has been seen in the course of study, quite a large number of mills did not take up the technology after successful completion of trial runs.

Modifying the rigid hierarchical organisational structure of NSI, making an atmosphere of creativity by providing due recognition for successfully transferring technologies, by introducing performance-based appraisal system and by allowing scientists to take up consultancy work of their own as can be seen in some of the leading technological institutes of the country, can go a long way in providing the stimulus for successful technology transfer.

It has been felt during the study that during the licensing stage NRDC should allow more involvement of NSI for better transfer. Now once NRDC comes into the picture the licensee interacts only with NRDC, but direct interaction with source seems to be of more facilitatory nature for successful transfer process.

8.4 Scope for Further Study.

The very nature of the study points out directions for future study.

a) The present study could not gather sufficient insight into the decision making process at the source (NSI) level during the project finalisation stage and at the user level during the taking or rejecting a particular technology.

b) Future study can focus on how exactly sectoral policies affect the nature and speed of technology transfer.

c) Studies can also attempt to highlight the role played by NRDC in transfer of technologies from Govt. controlled R and D units to users.

d) The present study attempted to give an overall picture of the transfer process. Further studies can highlight issues relating to each of the stages.

REFERENCES

1. D. Schon, Technology and Change, Delacorte Press, New York, 1967.

2. S. Chaudhuri and T.K. Moulik, Learning by Doing: Technology Transfer to an Indian Manufacturing Firm, Working Paper No. 540, Nov. 1984, IIM Ahmedabad, pp. 1.

3. A.K. Banerjee, "Absorption of Technology," Lok Udyog, July, 1977.

4. R.C. Mascarenhas, Technology Transfer and Development, India's Hindustan Machine Tools Co., Westview Replica Ed. 1982, pp. 1.

5. W. Morehouse, Science in India - Institution Building and the Organisational System for R and D, ASCI Occasional Paper, Popular Prakashan, Bombay, 1971, pp. 2,3,13.

6. R.C. Mascarenhas, op.cit., pp. 2.

7. S. Chaudhuri, Technological Innovation in a National Laboratory in India: A Case Study, Working Paper No. 512, June, 1984, IIM Ahmedabad.

8. R.C. Mascarenhas, op.cit., pp. 3.

9. P. Mitra, "Utilisation of Indigenous Technology: Organisational and Policy Constraints," Economic and Political Weekly, Nov., 1981, pp. M 153-M 163.

10. Baldev Singh, Problems of Research Utilisation, Management of Scientific Research, Ed. Jitendra Singh, ASCI Occasional Paper, Popular Prakashan, Bombay, 1973, pp. 257.

11. P. Mitra, op.cit.

12. Centre for Monitoring Indian Economy, Basic Statistics Relating to the Indian Economy, Vol. 1, All India, Aug. 1987, Table 11.4.

13. 32nd Annual Report of NRDC, 1985-86.

14. Albert H. Rubenstein, "R and D Issues in Developing Countries," TIMS Studies in Management Sciences, Vol. 15, Management of Research and Innovation, Ed. by B.V. Dean and J.L. Goldhar, Amsterdam, 1980, pp. 273.

15. Ruddar Dutt and K.P.M. Sundharam, Indian Economy, pp.562.

16. Ignatius Chithelen, "Payment of Cane Price by Maharastras Sugar Cooperatives," Economic and Political Weekly, December 24, 1983, pp. A-121.

17. Mar Singh, "Planning for Higher Productivity in Sugar Industry of India," Indian Sugar, August, 1984, pp. 421.

18. ISMA Workshop on Instrumentation and Process Control Systems in Sugar Industry, Indian Sugar, Nov., 1984, pp. 603

19. Editorial, Indian Sugar, July, 1986.

20. Editorial, Indian Sugar, April, 1985.

21. Editorial, Indian Sugar, June, 1986.

22. Editorial, Indian Sugar, July, 1986.

23. Editorial, Indian Sugar, Sept., 1985.

24. Editorial, Indian Sugar, May, 1984.

25. Editorial, Indian Sugar, July, 1986.

26. Ranjit Puri, "Modern Technological Developments in Indian Sugar Industry," Indian Sugar, October 1982, pp. 445.

27. Dutt and Sundharam, op.cit., pp. 564.

28. Ibid., pp. 564.

29. Ranjit Puri, op.cit.

30. Mangal Singh, "Research and Development in Sugar Industry in India," Indian Sugar, March, 1984, pp. 793.

31. M.C. Mascarenhas, op.cit., pp. xi.

32. W.H. Gruber and D.G. Marquis, Factors in the Transfer of Technology, The MIT Press, MIT Cambridge, 1969, pp.6.

51. Brian Twiss, op.cit., pp. 116.

52. J.J. Smith, et.al.,"Lessons from 10 case Studies in Innovation", Research Management, Vol. XXII, No. 5, pp. 23-27.

53. S. Chaudhuri, op.cit.

54. R.C. Mascarenhas, op.cit.

55. Ibid., pp. 23.

56. M.S. Mitra,"Organisation and Role of Consulting Engineering Companies in the Transfer of Technology", Lok Udyog, March, 1976. pp. 39.

57. . Morehouse, op.cit., pp. 6-10.

58. P. Mitra, op.cit.

59. S. Chaudhuri, op.cit.

60. S. Chaudhuri,"Technology Development for Commercial Industry," Productivity, April-June, 1984, pp. 28-34.

61. Z.A. Gangjee, op.cit., pp. 86.

62. Working Paper, Management of Scientific Research, Ed. Jitendra Singh, ASCI Occasional Paper, Popular Prakashan, Bombay, 1973, pp. 19-47.

63. C. Selltiz, M. Jahoda, M. Deutsch and S.W. Cook, Research Methods in Social Relations, Holt, Rinehart and Winston, USA, 1963, pp. 236-278.

APPENDIX

The two questionnaires, one each for NSI and the sugar mills, are given here.

This questionaire is for collecting information regarding the transfer of the technology titled - - - - - - - - - - - - - -

- -

from NSI, which is being studied by Mr. Arnab Bhattacharya of I.I.T. Kanpur as part of his M.Tech thesis work on TECHNOLOGY TRANSFER PROCESS FROM A NATIONAL LABORATORY under the guidance of Dr. A.P. Sinha of Industrial & Management Engineering Programme, I.I.T. Kanpur. The information will be used for academic work only.

1. Where did the idea for the new technology originate?
Pl tick in the box.

- ☐ i) Survey of sugar factories
- ☐ ii) Foreign literature (Pl. Specify)
- ☐ iii) Indian Literature (Pl. specify)
- ☐ iv) Current research already being done at NSI
- ☐ v) Request from a specific person or factory (Pl. give the name)
- ☐ vi) Through suggestion/request from any other R and D organisation (Pl. give the name)
- ☐ vii) Any other (Give details)

2. (a) Was a survey of potential users of the technology done before research work started? - YES/NO

(b) If 'YES' how was it done?

(c) How many potential users did the survey show? (Give number)

3. (a) Did any sugar factory or any other organisation (like NRDC) approach NSI to sponsor the project? YES/NO. (give name in case of 'YES')

(b) If 'YES' Pl. give brief details of the sponsorship contract.

4. (a) Did NSI try to get sponsorship from any factory or organisation? if 'YES' name the factory/organisation.
YES/NO

(b) If 'YES' did NSI get the sponsorship? Pl. give the details.

5. Was a costing of the research and its end-product done before research started?

...sting of Research–YES/NO
...sting of End product– YES/NO

6. Was a time limit set for the research project? – YES/NO

7. Please fill to the best possible (ignore items which are not related to your project) the dates of the relevent milestone in the history of the project.

	Month	Year
(i) Idea generated in		
(ii) Project approaved (internally) in		
(iii) Sponsorship finalised in		
(iv) Critical recruitment done (if any) in		
(v) Critical equipment arived (if any) in		
(vi) Successful completion of R and D in Lab in		
(vii) Pilot plant started functioning in		
(viii) Final scale commercial run in		
(ix) Patented by NRDC in		
(x) Licensed by NRDC to manufacturer in		

8. How many people in NSI were directly connected with the research and development of the technology?

No.	Name and Designation (at the time of the project)	No. of years involved in the project
i)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		

(attach sheet if necessary)

9. Were facilities for prototype testing/pilot plant running available at NSI? YES/NO

10. If 'NO' tick how it was done : (Please tick in the box)

☐ (i) NSI bought new equipments
☐ (ii) NSI financed equipments for use at sugar mill
☐ (iii) Sugar mill permitted use of their equipment
☐ (iv) Sugar mill bought new equipments
☐ (v) Anything else, please specify.

Please name the sugar mill/sugar mills in case your answer is (ii) or (iii) or (iv).

11. Compared to local existing technology the new technology was: (Please tick in the box)

☐ (i) a dramatic improvement
☐ (ii) a fairly great improvement
☐ (iii) somewhat of an improvement
☐ (iv) a very slight improvement
☐ (v) almost the same.

12. As regards the principles and techniques employed, the new technology was: (Please tick in the box)

☐ (i) radically different
☐ (ii) greatly different
☐ (iii) somewhat different
☐ (iv) slightly different
☐ (v) almost the same.

13. Compared to local existing technology which of the following characteristics did the new technology have: (Pl. tick, more than one if reqd.)

- ☐ (i) lowering the cost of process material
- ☐ (ii) improvement in output quantity
- ☐ (iii) improvement in output quality
- ☐ (iv) ability to substitute scarce inputs
- ☐ (v) Import substitution
- ☐ (vi) Saving in use of power.
- ☐ (vii) Any other (Pl. Specify)

14 (a) Could a sponsor/user of the technology try it out before he committed himself totally to it? YES / NO

(b) If the technology could be tried out, would the trial involve

(i)	heavy operating cost	YES/NO
(ii)	heavy capital investment	YES/NO
(iii)	high risk to output quality	YES/NO
(iv)	high risk to output quantity	YES/NO
(v)	tying up very important equipment of user	YES/NO

15. (a) If the sponsor/user took the technology would it enhance its prestige in his industry? YES/NO

(b) If 'YES', because of (i) NSI's Name?- YES/NO

(ii) the technology itself? YES/No

(iii) Anything else, Pl. specify.

16. Please indicate the manner in which potential sponsors/users were approached at various stages of technology development. (Pl. tick under the relevant column)

	Project Proposal Stage I	Pilot Testing Stage II	Technology Licensing/ Implement Stage. III
(i) by NSI's official circular			
(ii) by NSI's journal/bulletin			

	I	II	III
(iii) Through advertisement in the news papers			
(iv) by writing individual letters			
(v) by personnally contacting top people in the industry.			
(vi) Through seminars			
(vii) by any teehnical/commercial journal/ magazine (Pl.give the name)			
(ix) Any other, Pl. Specify:			

17. Did the user/sponsor have the following characteristics?
Pl. tick, more than one if reqd.

☐ (i) Nearness to NSI geographically
☐ (ii) Existing facilities were correct for the new technology
☐ (iii) Staff had the required background and training
☐ (iv) Had enough money to put into development work
☐ (v) Had a good R and D set up
☐ (vi) it was a small scale industry
☐ (vii) any thing else, pl. specify.

18. Did the user have to add new facilities to those existing when he took the new technology? YES/NO.

19. (a) Would the staff of the user have to be given training for developing/using the new technology? YES/NO

(b) If 'YES' by whom? (Pl. tick in the box)

☐ (i) NSI
☐ (ii) Other agency (pl. specify)
☐ (iii) Own organisation.

20. Was any study done regarding its effect on the labour forces/ technicians (concerning their work habits, pay, rehabilitation etc)? YES /NO

If 'YES' whenwas it done? (Pl. tick in the box)

☐ (i) before signing contract
☐ (ii) development stage
☐ (iii) use/selling stage
☐ (iv) Any other (Pl. Specify)

1. What was the nature of contract/agreement signed between NSI and the sponsor/user/NRDC?

2. Were the stipulations in the contract adequate in your opinion? YES/NO.

If 'NO' what are the changes you would like to have introduced? (Pl. tick in the box)

- ☐ (i) increase in royalty to be paid to NSI
- ☐ (ii) increase in lumpsum fee
- ☐ (iii) A penalty clause in case of non-use
- ☐ (iv) A fixed time period within which contract must be fulfilled.
- ☐ (v) Any other, pl. specify.

3. Once a sponsor/user was found how, and how often did NSI keep in touch with them in the following stages:

	Project Proposal Stage	Pilot Testing Stage	Technology Licensing Implement Stage.
(i) By sending over a person/team			
(ii) Written communication			
(iii) Telephone			
(iv) Others (Pl. Specify)			

4. How many times did the sponsor/user contact you (and how) in the following stages :

	Project Proposal Stage	Pilot Testing Stage	Technology Licensing/ Implement Stage
(i) By sending over a person/team			
(ii) Written communication			
(iii) Telephone			
(iv) Others (P. Specify)			

25. Did NSI perceive any resistance to its technology from:
(Pl tick, more than one if reqd)
- ☐ (i) Labour force and technicians of the user
- ☐ (ii) R and D people of the user
- ☐ (iii) Sugar Mills Association
- ☐ (iv) State Government
- ☐ (v) Others.

26. Did you know any one in the sponsor/user organisation prior to their taking the technology? YES/NO
If 'YES', mention Designation.

27. In NSI itself was there any special incentive given for successfully transfering the technology? — YES/NO

If 'YES' what form did it take?
(Pl. tick, more than one if reqd.)
- ☐ (i) Promotion
- ☐ (ii) Increment
- ☐ (iii) A percentage of the money received from the tehnology sponsor/user
- ☐ (iv) public praise
- ☐ (v) Congratulations by Director
- ☐ (vi) Prase from other personnel in NSI
- ☐ (vii) Others

28. Do you think any Government policy has helped or hindered in commercial exploitation of the technology? In which way? Pl. give a brief details.

29. Has NRDC given a patent for the output of this research? YES/NO
(Pl. name the firms to whom NRDC has given the license to manufacture that.) If 'YES' was there any communication between NSI and the firm to whom NRDC has ~~xix~~ given license to manufacture that?

30. What was the system of work while working in this project?

31(a) Is it a practice for NSI to look for sponsorship for any project? YES/NO

(b) If 'YES', pl. give details about the systems.

32(a) Do you have a check list of characteristics to use as criteria when selecting a sponsor? YES/NO

(b) If 'YES' which of the following characteristics are used? (Please tick, more than one if required).

☐ (i) Small scale Sugar mill
☐ (ii) Big sugar mill
☐ (iii) Nearness to NSI goegrophically
☐ (iv) Staff have the required background and training
☐ (v) Has enough money to put into development work
☐ (vi) Has a good R&D set up.
☐ (vii) Any other, please specify.

(c) Do you have a checklist of characteristics to use as criteria when selecting an user? YES/NO

(d) If 'YES', which of the following characteristics are used? (please tick, more than one if required).

☐ (i) Small scale sugar mill
☐ (ii) Big sugar mill
☐ (iii) Neareness to NSI geographically
☐ (iv) Sick sugar mill
☐ (v) Staff have the required background and training
☐ (vi) Has enough money to put into development work
☐ (vii) Has a good R & D set up.
☐ (viii) Any other, please specify.

33. Should NSI

(a) Undertake market research for sponsors / users- YES/NO

(b) Locate users for the end product of the technology YES/NO

34. How do you rate the potential sponsors/ users of the technology, <u>as a group</u>, on the following characteristics: (Please tick under the relevent column).

	High	Average	Low
(i) Technical competency in their field			
(ii) Openess to new technology in general			
(iii) Being up-to-date with the latest in their field			
(iv) Ability to adopt to changing situations.			
(v) Cooperativeness with NSI			
(vi) Positive attitude towards NSI			
(vii) Positive attitude towards R & D activity			

35. How do you keep in touch with those people in industry who share your professional interest? (Pl. tick more than one if required).

☐ (i) through seminar, convention organised by NSI
☐ (ii) interchange of information through letters
☐ (iii) through meetings of sugar technologists' Association
☐ (iv) through informal meeting, get-togather etc.
☐ (v) Any other, please specify

36. Do you think NSI is not interacting enough with other related R & D organisation? YES/NO

37. Please name the R&D organisations with whom you think NSI should increase interaction.

38. Why do you think more people do not come forward with requests for new technology?

39. Have you any suggestion to offer to make research at NSI more user-oriented?

40. When a sponsor/ user contacts NSI with any new idea, how NSI arives at a decision regarding feasibility and starting R & D work on it?

41. What is the role of Information & Survey division during technology transfer? (Please tick)

- ☐ (i) All types of documentation
- ☐ (ii) Clearing house for information
- ☐ (iii) Agency through which NSI interacts with out side party
- ☐ (iv) Cordinates activity among different departments
- ☐ (v) Sends persons / team to user mill of technology for training people/development of technology
- ☐ (vi) Any other , Please specify.

TO THE RESPONDENT OF THIS QUESTIONNAIRE

This questionnaire is meant to understand the process of technology transfer from National Sugar Institute to Sugar mills. It is a purely academic study for an M.Tech. thesis.

While answering, please refer to only one of the following two technologies transferred to your mill from NSI :

1. Pre-harvest maturity survey.
2. Sushira : Surface active substance for reducing Pol and moisture in bagasse.

A separate questionnaire will be required for each technology. The researcher will personally call on you to discuss and clarify the various aspects of this questionnaire:

QUESTIONNAIRE ON TECHNOLOGY TRANSFER

The responses in this questionnaire refer to

☐ Preharvest maturity survey

☐ Sushira: Surface active substance for reducing Pol and moisture in bagasse.

(Tick one only)

TO THE RESPONDENT OF THIS QUESTIONNAIRE

This questionnaire is meant to understand the process of Technology Transfer from National Sugar Institute to Sugar Mills. If is a purely academic study for an M.Tech. Thesis.

While answering, please refer to the following technology, transferred to your mill from NSI:

Extraction of sugar from sugar-beet.

The researcher will personally call on you to discuss and clarify the various aspects of this questionaire.

1. How were you first made aware of the availability of NSI's technology? Please tick in the box.

- ☐ i) By NSI's official circular
- ☐ ii) By a letter from NSI
- ☐ iii) By being personally contacted by NSI's Director
- ☐ iv) Through STA's seminar
- ☐ v) Via NSI. news
- ☐ vi) Through informal contact with NSI's people
- ☐ vii) Through informal contact with others in the industry
- ☐ viii) Any other, please specify.

2. Please name the person/ persons in your organization who were involved in the development/usage of the technology.

	Name	Qualification	Designation
i)			
ii)			
iii)			
iv)			

3. Who made the final decision regarding using the technology:

	Name	Designation
i)		
ii)		
iii)		
iv)		

4. Was any technoeconomic feasibility analysis done before committing to use the technology? YES/NO.

5. Please indicate the manner in which NSI kept in touch with you at various stages of technology development (tick corresponding to relevant row).

	Project proposal stage	Testing stage	Technology Implementation stage
i) By sending over a person / team			
ii) Written Communication			
iii) Telephonic Conversation			
iv) Any other, please specify			

6. Before taking the technology did you provide facilities for testing/ pilot plant running of the technology to NSI? YES/NO

If'YES' ,Please give a brief details about the facilities provided.

7. Compared to local existing technology the new technology was: (Please tick in the box)

- ☐ i) a dramatic improvement
- ☐ ii) a fairly great improvement
- ☐ iii) somewhat of an improvement
- ☐ iv) a very slight improvement
- ☐ v) almost the same.

8. As regards the principles and techniques employed, the new technology was : (Please tick in the box)

- ☐ i) radically different
- ☐ ii) greatly different
- ☐ iii) some-what different
- ☐ iv) slightly different
- ☐ v) almost the same.

9. Compared to local existing technology which of the following characteristics did the new technology have? (Please tick , more than one if reqd.)

- ☐ i) lowering the cost of process material
- ☐ ii) improvement in output quantity
- ☐ iii) improvement in output quality
- ☐ iv) ability to substitute scarce inputs
- ☐ v) import substitution
- ☐ vi) saving in use of power
- ☐ vii) any other, please specify.

10 (a) Could an user of the technology try it out before he committed himself totally to it? YES /NO

(b) If ' YES' would it involve

(i) Heavy operating cost- YES/NO

(ii) Heavy capital investment - YES/NO

(iii) High risk to output quality - YES/NO

(iv) High risk to output quantity - YES/NO

(v) Tying up very important equipment of user - YES/NO

11 (a) Did you have to add new facilities to your existing ones when you took the technology? YES/ NO

(b) Was the regular work slowed down or hampered when new technology was taken? YES/NO

12.(a) Was new personnel have to be hired when you took on the new technology? YES/NO

(b) If 'YES', how many new personnel were hired?

Scientist:
Engineers:
Technicians:
Labour :
Other (Please specify):

13 (a) Was the staff have to be given training for developing/ using the new technology? YES/NO

(b) If 'YES',by whom? (please tick in the box)

☐ (i) NSI
☐ (ii) Other agency (please specify)
☐ (iii) Your own organisation

14.(a) Were there many technical problems to be dealt with after taking the technology?, YES/NO.

(b) If 'YES' please give brief details.

5. (a) Were there many administrative or managerial problems to be dealt with after taking the technology? YES/NO

(b) If 'YES',Please give brief details.

6. (a) Was non-availability of funds a barrier in the path of taking the new technology? YES/NO

(b) If 'YES', how was the problem solved?

7. (a) Do you think your mill is more well known in the industry because of using this technology? YES/NO.

(b) If'YES' , is this because of (i) NSI's Name: YES/NO

(ii) the technology itself; YES/

(iii) anything else, please speci

8. Please give your own assesment of the following for the peri when NSI offered the technology;(please tick under the releva column)

	Good	Normal	Bad
(i) Financial situation of the mill			
(ii) Labour situation of the mill			
(iii) Power situation of the mill			
(iv) Market situation of the mill			
(v) Raw Material supply of the mill			

9. Does NSI's technology make your personnel too much dependent on NSI? YES/NO

20. Please rate the following aspects of NSI by ticking under the relevant column:

	Very Good	Good	Average	Poor	Very Poor
(i) Competence of NSI's personnel in their own disciplines					
(ii) Cooperativeness with Sugar Mills					
(iii) Openness to your suggestions					
(iv) Standard of NSI's Advisory Service					
(v) Standard of NSI's R & D work					

21. What are the technologies / services you would like from NSI in the future?

General Areas -

Details -

22. Please answer the following quaries regarding the size of your mill.

(a) Capacity (Tons/day)-
(b) Total Sales(Last year) -
(c) Total personnel -

23. For how many years are you in operation ? - Years

24. Please tick in which sector your mill falls:
Government Mill/ Joint Sector/ Private Sector/ Cooperative

25. (a) Dos your organisation have its own library? YES/NO
If 'YES', how many books does it contain?
(b) How many journals dos your organisation subscribe to?
(c) How many members of your organisation do you send yearly for training, seminars, conferences etc.? (give an average no.).

26. In case you have a separate R & D department please answer the following:

(a) How many people do you have in your R & D department?

(b) Can you give (in order of seniority) their highest qualification and no. of years in service?